## Additional File 2: iTT548 model in sbml format

```
<?xml version="1.0" encoding="UTF-8"?>
<sbml xmlns="http://www.sbml.org/sbml/level2" level="2" version="1">
<model>
  <listOfUnitDefinitions>
   <unitDefinition id="mmol_per_gDW_per_hr">
    distOfUnits>
     <unit kind="mole" exponent="1" scale="-3" multiplier="1" offset="0"/>
     <unit kind="gram" exponent="-1" scale="0" multiplier="1" offset="0"/>
     <unit kind="second" exponent="-1" scale="0" multiplier="0.0002777777777778" offset="0"/>
    </listOfUnits>
   </unitDefinition>
  </listOfUnitDefinitions>
  <listOfCompartments>
   <compartment id="c" name="Cytoplasm" spatialDimensions="3" constant="true"/>
   <compartment id="e" name="Extracellular" spatialDimensions="3" constant="true"/>
  /listOfCompartments>
  distOfSpecies>
   <species id="M_L_ASP_c" name="L-Aspartate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C4H7NO4
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_L\_GLU\_c" name="L-Glutamate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
```

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<notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C5H9NO4
                     CHARGE: 0
                  </body>
               </notes>
           </species>
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constant="false">
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                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C3H7NO3
                     CHARGE: 0
                  </body>
               </notes>
           </species>
           <species id="M_L_HIS_c" name="L-Histidine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
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                  <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C6H9N3O2
                     CHARGE: 0
                  </body>
               </notes>
           </species>
           <species id="M_L_GLY_c" name="Glycine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C2H5NO2
```

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CHARGE: 0
                               </body>
                          </notes>
                   </species>
                   <species id="M_L_THR_c" name="L-Threonine" compartment="c" hasOnlySubstanceUnits="false"</pre>
 boundaryCondition="false" constant="false">
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                               <body xmlns="http://www.w3.org/1999/xhtml">
                                     FORMULA: C4H9NO3
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                               </body>
                          </notes>
                   </species>
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                               </body>
                          </notes>
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constant="false">
                          <notes>
                               <body xmlns="http://www.w3.org/1999/xhtml">
                                      FORMULA: C3H7NO2
                                     CHARGE: 0
                               </body>
                          </notes>
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</species>
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constant="false">
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                    FORMULA: C9H11NO3
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                 </body>
             </notes>
          </species>
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constant="false">
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                    FORMULA: C5H11NO2
                    CHARGE: 0
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          </species>
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boundaryCondition="false" constant="false">
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                    CHARGE: 0
                 </body>
             </notes>
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constant="false">
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constant="false">
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                   FORMULA: C6H14N2O2
                   CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_L_PRO_c" name="L-Proline" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
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                   FORMULA: C5H9NO2
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CHARGE: 0
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              </notes>
          </species>
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boundaryCondition="false" constant="false">
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          </species>
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constant="false">
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                    CHARGE: 0
                 </body>
              </notes>
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boundaryCondition="false" constant="false">
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                    CHARGE: 0
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              </notes>
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</species>
        <species id="M L MET c" name="L-Methionine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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              <body xmlns="http://www.w3.org/1999/xhtml">
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boundaryCondition="false" constant="false">
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                  FORMULA: C11H12N2O2
                 CHARGE: 0
              </body>
            </notes>
        </species>
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boundaryCondition="false" constant="false">
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            </notes>
        </species>
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boundaryCondition="false" constant="false">
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<notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C17H27N3O17P2
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boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C5H9NO4
                   CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_ORT_c" name="L-Ornithine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C5H12N2O2
                   CHARGE: 0
                </body>
             </notes>
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constant="false">
             <notes>
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                   FORMULA: C3H7NO2
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CHARGE: 0
    </body>
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  </species>
  <species id="M_dTTP_c" name="Deoxythymidine triphosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H17N2O14P3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_dGTP_c" name="2&apos;-Deoxyguanosine 5&apos;-triphosphate (dGTP)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H16N5O13P3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_dCTP_c" name="Deoxycytidine 5&apos;-triphosphate (dCTP)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H16N3O13P3
     CHARGE: 0
    </body>
   </notes>
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</species>
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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                   FORMULA: C10H16N5O12P3
                   CHARGE: 0
               </body>
            </notes>
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         <species id="M_CTP_c" name="Cytidine 5&apos;-triphosphate (CTP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
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                   FORMULA: C9H16N3O14P3
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               </body>
            </notes>
         </species>
         <species id="M_GTP_c" name="Guanosine 5&apos;-triphosphate (GTP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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               <body xmlns="http://www.w3.org/1999/xhtml">
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            </notes>
         </species>
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boundaryCondition="false" constant="false">
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<notes>
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     FORMULA: C9H15N2O15P3
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    </notes>
   </species>
   <\!\!\text{species id="M\_MGDG\_c" name="monoglucosyl-1,2 diacylglycerol" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
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     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_DGDG_c" name="diglucosyl-1,2 diacylglycerol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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     FORMULA: 
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     </body>
    </notes>
   </species>
   <species id="M_tZXT_c" name="Thermozeaxanthin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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     FORMULA: C59H90O8
```

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CHARGE: 0
                                </body>
                           </notes>
                   </species>
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 boundaryCondition="false" constant="false">
                           <notes>
                                <body xmlns="http://www.w3.org/1999/xhtml">
                                      FORMULA: C7H12NO8PR2
                                      CHARGE: 0
                                </body>
                           </notes>
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boundaryCondition="false" constant="false">
                           <notes>
                                <body xmlns="http://www.w3.org/1999/xhtml">
                                      FORMULA: 
                                      CHARGE: 0
                                </body>
                           </notes>
                   </species>
                   <\!\!\text{species id} = \text{"M\_PINS\_c" name} = \text{"1-phosphatidyl-inositol" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" longitudes of the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" longitudes of the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" longitudes of the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" longitudes of the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" longitudes of the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" longitudes of the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" longitudes of the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"c" hasOnlySubs
 boundaryCondition="false" constant="false">
                           <notes>
                                <body xmlns="http://www.w3.org/1999/xhtml">
                                       FORMULA: 
                                      CHARGE: 0
                                </body>
                           </notes>
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</species>
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boundaryCondition="false" constant="false">
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      CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_PX_c" name="N-acylphosphoethanolamine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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      FORMULA: 
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ATP_c" name="Adenosine 5&apos;-triphosphate (ATP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H16N5O13P3
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ADP_c" name="Adenosine 5&apos;-diphosphate (ADP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H15N5O10P2
     CHARGE: 0
    </body>
    </notes>
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boundaryCondition="false" constant="false">
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      FORMULA: H3PO4
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    </body>
    </notes>
   </species>
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constant="false">
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     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_H2O_c" name="Water" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: H2O
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CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_H_c" name="Hydron" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: H
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\!\text{species id="M\_D\_GLC\_c" name="D-Glucose" compartment="c" has Only Substance Units="false" boundary Condition="false" and the compartment of the compartment of
constant="false">
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                    FORMULA: C6H12O6
                    CHARGE: 0
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              </notes>
          </species>
          <species id="M_G6P_c" name="D-Glucose 6-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C6H13O9P
                    CHARGE: 0
                 </body>
              </notes>
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</species>
  <species id="M D MAN c" name="D-Mannose" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H12O6
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_M6P_c" name="D-Mannose 6-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O9P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_F6P_c" name="D-Fructose 6-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O9P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_FBP_c" name="D-Fructose 1,6-bisphosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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<notes>
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    </body>
   </notes>
  </species>
  <species id="M_DHAP_c" name="Dihydroxyacetone phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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    </body>
   </notes>
  </species>
  <species id="M_GAP_c" name="D-Glyceraldehyde 3-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H7O6P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_NAD_c" name="Nicotinamide adenine dinucleotide (NAD)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C21H28N7O14P2
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CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_13BPG_c" name="1,3-Bisphospho-D-glycerate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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     FORMULA: C3H8O10P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_NADH_c" name="Nicotinamide adenine dinucleotide (NADH)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C21H29N7O14P2
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   </notes>
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boundaryCondition="false" constant="false">
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     FORMULA: C3H7O7P
     CHARGE: 0
    </body>
   </notes>
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boundaryCondition="false" constant="false">
    <notes>
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      FORMULA: C3H7O7P
      CHARGE: 0
    </body>
    </notes>
  </species>
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boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C3H5O6P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_PYR_c" name="Pyruvate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H4O3
     CHARGE: 0
    </body>
    </notes>
  </species>
  <\!\!\text{species id="M\_OAC\_c" name="Oxaloacetate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
```

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<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H4O5
     CHARGE: 0
    </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_CO2\_c" name="Carbon dioxide" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: CO2
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_LAC_c" name="L-Lactate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H6O3
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_CoA_c" name="Coenzyme A (CoA)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C21H36N7O16P3S
```

```
CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_AC_c" name="Acetate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H4O2
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_AMP_c" name="Adenosine 5&apos;-monophosphate (AMP)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H14N5O7P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ACoA_c" name="Acetyl-CoA" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C23H38N7O17P3S
     CHARGE: 0
    </body>
    </notes>
```

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</species>
   <species id="M_AALD_c" name="Acetaldehyde" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C2H4O
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_ETH_c" name="Ethanol" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C2H6O
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_CIT_c" name="Citrate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C6H8O7
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M_cACO\_c" name="cis-Aconitate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
```

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<notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C6H6O6
                   CHARGE: 0
                </body>
             </notes>
         </species>
         <\!\!\text{species id="M_ICIT\_c" name="Isocitrate" compartment="c" has Only Substance Units="false" boundary Condition="false" and the compartment of 
constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C6H8O7
                   CHARGE: 0
                </body>
             </notes>
         </species>
         <species id="M_NADP_c" name="Nicotinamide adenine dinucleotide phosphate (NADP)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C21H29N7O17P3
                   CHARGE: 0
                </body>
             </notes>
         </species>
         <species id="M_OXLSUCC_c" name="Oxalosuccinate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C6H6O7
```

```
CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_NADPH_c" name="Reduced nicotinamide adenine dinucleotide phosphate (NADPH)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C21H30N7O17P3
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_AKG\_c" name="alpha-Ketoglutaric acid" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H6O5
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_SUCCoA\_c" name="Succinyl-CoA" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C25H40N7O19P3S
     CHARGE: 0
     </body>
    </notes>
```

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</species>
  <species id="M SUCC c" name="Succinate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H6O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_FAD_c" name="Flavin adenine dinucleotide (FAD)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C27H33N9O15P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_FADH2_c" name="Reduced Flavin adenine dinucleotide (FADH2)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C27H35N9O15P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_FUM_c" name="Fumarate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
```

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<notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C4H4O4
                   CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_MAL_c" name="L-Malate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C4H6O5
                   CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_Q_c" name="Ubiquinone" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C14H18O4(C5H8)n
                   CHARGE: 0
                </body>
             </notes>
          </species>
          <\!\!\text{species id="M\_GLC\_LACN\_c" name="D-Glucono-1,5-lactone" compartment="c" has Only Substance Units="false" and the compartment of the compartm
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C6H10O6
```

```
CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_QH2_c" name="Ubiquinol" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C14H20O4(C5H8)n
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_E4P_c" name="D-Erythrose 4-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H9O7P
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_XYL5P_c" name="D-Xylulose 5-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C5H11O8P
     CHARGE: 0
    </body>
    </notes>
```

```
</species>
        <species id="M_SEDHEP7P_c" name="D-Sedoheptulose 7-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C7H15O10P
                  CHARGE: 0
               </body>
            </notes>
        </species>
        <\!\!\text{species id} = \text{"M\_R5P\_c" name} = \text{"D-Ribose 5-phosphate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" and the properties of the properti
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C5H11O8P
                 CHARGE: 0
               </body>
            </notes>
        </species>
        <species id="M_RBL5P_c" name="D-Ribulose 5-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                 FORMULA: C5H11O8P
                  CHARGE: 0
               </body>
            </notes>
        </species>
        <species id="M_PRPP_c" name="5-Phospho-alpha-D-ribose 1-diphosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
```

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<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H13O14P3
     CHARGE: 0
    </body>
    </notes>
   </species>
   <\!\!\text{species id="M_R1P_c" name="D-Ribose 1-phosphate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C5H11O8P
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_D_RIB_c" name="D-Ribose" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H10O5
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_dR5P_c" name="2-Deoxy-D-ribose 5-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H11O7P
```

```
CHARGE: 0
                             </body>
                        </notes>
                  </species>
                  <species id="M_dR1P_c" name="2-Deoxy-D-ribose 1-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
 boundaryCondition="false" constant="false">
                        <notes>
                             <body xmlns="http://www.w3.org/1999/xhtml">
                                   FORMULA: C5H11O7P
                                   CHARGE: 0
                             </body>
                        </notes>
                  </species>
                  <\!\!\text{species id} = \text{"M\_GLYALD\_c" name} = \text{"D-Glyceraldehyde" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" and the properties of the propertie
boundaryCondition="false" constant="false">
                        <notes>
                             <body xmlns="http://www.w3.org/1999/xhtml">
                                   FORMULA: C3H6O3
                                   CHARGE: 0
                             </body>
                        </notes>
                  </species>
                  <\!\!\text{species id} = \text{"M\_D\_GLCT\_c" name} = \text{"D-Glycerate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" and the property of the pr
 boundaryCondition="false" constant="false">
                        <notes>
                             <body xmlns="http://www.w3.org/1999/xhtml">
                                    FORMULA: C3H6O4
                                   CHARGE: 0
                             </body>
                        </notes>
```

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</species>
        <species id="M DHY DOP GLUCN c" name="2-Dehydro-3-deoxy-6-phospho-D-gluconate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 FORMULA: C6H11O9P
                 CHARGE: 0
              </body>
           </notes>
        </species>
        <species id="M_2K3DO_GLCN_c" name="2-Dehydro-3-deoxy-D-gluconate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 FORMULA: C6H10O6
                 CHARGE: 0
              </body>
           </notes>
        </species>
        <species id="M_DHY_DOHEXNA_c" name="(4S)-4,6-Dihydroxy-2,5-dioxohexanoate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 FORMULA: C6H8O6
                 CHARGE: 0
              </body>
           </notes>
        </species>
        <\!\!\text{species id} = \text{"M\_F1P\_c" name} = \text{"D-Fructose 1-phosphate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long the property of the property 
boundaryCondition="false" constant="false">
```

```
<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O9P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_FUCL1P_c" name="L-Fuculose 1-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O8P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_LALD_c" name="(S)-Lactaldehyde" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H6O2
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_GDP_MAN_c" name="GDP-D-mannose" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C16H25N5O16P2
```

```
CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_GDP_c" name="Guanosine 5&apos;-diphosphate (GDP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H15N5O11P2
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_MANNPGLYCT_c" name="2-(alpha-D-Mannosyl)-3-phosphoglycerate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H17O12P
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_AMANN_GLYCT_c" name="2(alpha-D-Mannosyl)-D-glycerate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C9H16O9
     CHARGE: 0
    </body>
    </notes>
```

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</species>
         <species id="M_MAN1P_c" name="D-Mannose 1-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C6H13O9P
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_D_FRU_c" name="D-Fructose" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C6H12O6
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_D_GAL_c" name="D-Galactose" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C6H12O6
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <\!\!\text{species id="M\_GAL1P\_c" name="alpha-D-Galactose 1-phosphate" compartment="c" has Only Substance Units="false" and the substance of the s
boundaryCondition="false" constant="false">
```

```
<notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O9P
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_UDP\_GLU\_c" name="UDP-D-glucose" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C15H24N2O17P2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_G1P_c" name="D-Glucose 1-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O9P
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_UDP\_GAL\_c" name="UDP-D-galactose" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C15H24N2O17P2
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```
CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_GLCTN_c" name="Galactan" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: (C12H20O11)n
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id="M\_LACTS\_c" name="Lactose" compartment="c" has Only Substance Units="false" boundary Condition="false" and the compartment of th
constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C12H22O11
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_EPMLBIOS_c" name="Epimelibiose" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C12H22O11
                    CHARGE: 0
                 </body>
              </notes>
```

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</species>
         <species id="M AGAL INS c" name="Galactinol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C12H22O11
                   CHARGE: 0
                </body>
             </notes>
         </species>
         <species id="M_M_INS_c" name="D-myo-Inositol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C6H12O6
                  CHARGE: 0
                </body>
             </notes>
         </species>
         <species id="M_MLBTL_c" name="Melibiitol" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C12H24O11
                  CHARGE: 0
                </body>
             </notes>
         </species>
         <\!\!\text{species id="M\_SORB\_c" name="D-Sorbitol" compartment="c" has Only Substance Units="false" boundary Condition="false" and the substance of the substance o
constant="false">
```

```
<notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H14O6
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\!\text{species id="M\_GALCS\_GLYC\_c" name="Galactosylglycerol" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C9H18O8
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_GLYCRL_c" name="Glycerol" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H8O3
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_STCYS_c" name="Stachyose" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C24H42O21
```

```
CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_RAFF_c" name="Raffinose" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C18H32O16
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\!\text{species id="M\_MANNTRIS\_c" name="Mannotriose" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C18H32O16
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_MLBIOS\_c" name="Melibiose" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C12H22O11
     CHARGE: 0
     </body>
    </notes>
```

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</species>
   <species id="M SUC c" name="Sucrose" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
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      FORMULA: C12H22O11
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PALT_c" name="Paltinose" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_ct_FARPPi_c" name="2-cis,6-trans-Farnesyl diphosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C15H28O7P2
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_IPEN_PPi_c" name="Isopentenyl diphosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
```

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<notes>
                             <body xmlns="http://www.w3.org/1999/xhtml">
                                  FORMULA: C5H12O7P2
                                  CHARGE: 0
                             </body>
                        </notes>
                 </species>
                 <\!\!\text{species id} = \text{"M\_t\_PPREPPi\_c" name} = \text{"all-trans-Polyprenyl diphosphate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" like the properties of the propert
 boundaryCondition="false" constant="false">
                        <notes>
                             <body xmlns="http://www.w3.org/1999/xhtml">
                                   FORMULA: C5H12O7P2(C5H8)n
                                  CHARGE: 0
                             </body>
                        </notes>
                 </species>
                 <species id="M_CORM_c" name="Chorismate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
                        <notes>
                             <body xmlns="http://www.w3.org/1999/xhtml">
                                  FORMULA: C10H10O6
                                   CHARGE: 0
                             </body>
                        </notes>
                 </species>
                 <\!\!\text{species id} = \text{"M\_HY\_BNZA\_c" name} = \text{"4-Hydroxybenzoate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"c" hasOnlySubstanceUnits} = \text{"c" hasOnlySubstance
 boundaryCondition="false" constant="false">
                        <notes>
                             <body xmlns="http://www.w3.org/1999/xhtml">
                                  FORMULA: C7H6O3
```

```
CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_HY_PPREBNZA_c" name="4-Hydroxy-3-polyprenylbenzoate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C12H14O3(C5H8)n
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_PPRENPhOL_c" name="2-Polyprenylphenol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C11H14O(C5H8)n
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_O2_c" name="Oxygen" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: O2
     CHARGE: 0
    </body>
    </notes>
```

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</species>
  <species id="M PBDIOL c" name="2-polyprenyl-6-hydroxyphenol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_SAM_c" name="S-Adenosyl-L-methionine (SAM)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C15H22N6O5S
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_METPPHOL_c" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
    </notes>
  </species>
  <\!\!\text{species id="M\_SAHC\_c" name="S-Adenosyl-L-homocysteine" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C14H20N6O5S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <\!\!\text{species id="M\_PPRE\_MOX\_BNZQ\_c"}\ name="2-Polyprenyl-6-methoxy-1,4-benzoquinone"\ compartment="c"
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C12H14O3(C5H8)n
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_DEMQH2_c" name="3-Demethylubiquinol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PPRE_MMOX_BNZQ_c" name="2-Polyprenyl-3-methyl-6-methoxy-1,4-benzoquinone" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C13H16O3(C5H8)n
```

<notes>

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CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_DMMQ_c" name="2-Demethylmenaquinone" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C15H14O2(C5H8)n
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_MQ\_c" name="Menaquinone" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C16H16O2(C5H8)n
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id} = \text{"M\_HY\_SUCC\_CYCHEXDE\_CARBA\_c" name} = \text{"(1R,6R)-6-Hydroxy-2-succinylcyclohexa-2,4-diene-1-carboxylate)} \\
(SHCHC)" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C11H12O6
      CHARGE: 0
     </body>
    </notes>
```

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</species>
  <species id="M_SUCC_BNZA_c" name="2-Succinylbenzoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C11H10O5
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_CBTN_CCP_c" name="Carboxybiotin-carboxyl-carrier protein" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C18H26N5O6SR2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_MALCoA_c" name="Malonyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C24H38N7O19P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  boundaryCondition="false" constant="false">
```

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<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C17H27N5O4SR2
     CHARGE: 0
    </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_GLUTRCoA\_c" name="Glutaryl-CoA" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C26H42N7O19P3S
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_CROCoA_c" name="Crotonoyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C25H40N7O17P3S
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_H_e" name="Hydron" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: H
```

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CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_CYT_C3_c" name="Ferricytochrome c" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C42H44FeN8O8S2R4
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_CYT_C2_c" name="Ferrocytochrome c" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C42H44FeN8O8S2R4
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ADP_RIB_c" name="ADP-D-ribose" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C15H23N5O14P2
     CHARGE: 0
    </body>
    </notes>
```

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</species>
        <species id="M PRIBSAMN c" name="5-Phosphoribosylamine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 FORMULA: C5H12NO7P
                 CHARGE: 0
              </body>
           </notes>
        </species>
        <species id="M_GAR_c" name="5&apos;-Phosphoribosylglycinamide (GAR)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 FORMULA: C7H15N2O8P
                CHARGE: 0
              </body>
           </notes>
        </species>
        <species id="M_FGAR_c" name="5&apos;-Phosphoribosyl-N-formylglycinamide (FGAR)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 FORMULA: C8H15N2O9P
                 CHARGE: 0
              </body>
           </notes>
        </species>
        <\!\!\text{species id="M_FGAM_c" name="2-(Formamido)-N1-(5\&apos;-phosphoribosyl)} ace tamidine "compartment="c" also be a comparable to the co
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
```

```
<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H16N3O8P
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_AIR_c" name="Aminoimidazole ribotide (AIR)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C8H14N3O7P
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_HCO3_c" name="Bicarbonate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: HCO3
      CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_5CAIZ_c" name="5-Carboxyamino-1-(5-phospho-D-ribosyl)imidazole" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H14N3O9P
```

```
CHARGE: 0
                  </body>
               </notes>
           </species>
           <species id="M_CAIR_c" name="1-(5-Phospho-D-ribosyl)-5-amino-4-imidazolecarboxylate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C9H14N3O9P
                     CHARGE: 0
                  </body>
               </notes>
           </species>
           <species id="M_SAICAR_c" name="1-(5&apos;-Phosphoribosyl)-5-amino-4-(N-succinocarboxamide)-imidazole (SAICAR)"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C13H19N4O12P
                      CHARGE: 0
                  </body>
               </notes>
           </species>
           <\!\!\text{species id} = \text{"M\_AICAR\_c" name} = \text{"1-(5\&apos;-Phosphoribosyl)-5-amino-4-imidazolecarboxamide" compartment} = \text{"c" name} = \text{"c" na
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C9H15N4O8P
                     CHARGE: 0
                  </body>
               </notes>
```

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</species>
  <species id="M 5A 4IMDZCARBA c" name="5-Amino-4-imidazolecarboxyamide" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C4H6N4O
      CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_10F_THF_c" name="10-Formyltetrahydrofolate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C20H23N7O7
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_THF_c" name="5,6,7,8-Tetrahydrofolate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C19H23N7O6
      CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_FAICAR_c" name="1-(5&apos;-Phosphoribosyl)-5-formamido-4-imidazolecarboxamide (FAICAR)"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
```

```
<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H15N4O9P
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_IMP_c" name="Inosine monophosphate (IMP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C10H13N4O8P
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_BADNS_PPP_c" name="P1,P4-Bis(5&apos;-adenosyl) tetraphosphate (AppppA)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C20H28N10O19P4
      CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_SO4_c" name="Sulfate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: H2SO4
```

```
CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_APS_c" name="Adenylyl sulfate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H14N5O10PS
     CHARGE: 0
    </body>
   </notes>
  </species>
  <\!\!\text{species id="M\_dIDP\_c" name="2\&apos;-Deoxyinosine-5\&apos;-diphosphate (dIDP)" compartment="c"}
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H14N4O10P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_dITP_c" name="2&apos;-Deoxyinosine-5&apos;-triphosphate (dITP)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H15N4O13P3
     CHARGE: 0
    </body>
   </notes>
```

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</species>
  <species id="M dIMP c" name="2&apos;-Deoxyinosine 5&apos;-phosphate (dIMP)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H13N4O7P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GUNS_3PPi_5TPi_c" name="Guanosine 3&apos;-diphosphate 5&apos;-triphosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H18N5O20P5
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GUNSBP_c" name="Guanosine 3&apos;-diphosphate 5&apos;-diphosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H17N5O17P4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GMP_c" name="Guanosine 5&apos;-phosphate (GMP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
```

```
<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H14N5O8P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_BGUNS_PPP_c" name="P1,P4-Bis(5&apos;-guanosyl) tetraphosphate (GppppG)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C20H28N10O21P4
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_dGUNS_c" name="Deoxyguanosine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H13N5O4
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_TPi_c" name="Triphosphate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: P3H5O10
```

```
CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_dGDP_c" name="2&apos;-Deoxyguanosine 5&apos;-diphosphate (dGDP)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C10H15N5O10P2
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_dGMP_c" name="Deoxyguanosine monophosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C10H14N5O7P
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_R\_TRED\_c" name} = \text{"Reduced thioredoxin" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" and the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"c" hasOnlySubsta
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C10H14N4O4S2R4
                    CHARGE: 0
                 </body>
              </notes>
```

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</species>
  <species id="M O TRED c" name="Oxidized thioredoxin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H12N4O4S2R4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GUN_c" name="Guanine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H5N5O
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GUNS_c" name="Guanosine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H13N5O5
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_XMP_c" name="Xanthosine 5&apos;-phosphate (XMP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
```

```
<notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C10H13N4O9P
                    CHARGE: 0
                 </body>
              </notes>
          </species>
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CHARGE: 0
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    </notes>
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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CHARGE: 0
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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  </species>
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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CHARGE: 0
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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</species>
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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CHARGE: 0
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constant="false">
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boundaryCondition="false" constant="false">
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             </notes>
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</species>
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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    </notes>
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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CHARGE: 0
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boundaryCondition="false" constant="false">
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             </notes>
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boundaryCondition="false" constant="false">
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constant="false">
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
    <notes>
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     FORMULA: C6H14NO8P
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CHARGE: 0
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boundaryCondition="false" constant="false">
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</species>
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constant="false">
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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                       </notes>
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<notes>
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    </notes>
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boundaryCondition="false" constant="false">
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     FORMULA: C4H9NO3
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CHARGE: 0
     </body>
    </notes>
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boundaryCondition="false" constant="false">
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    </notes>
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boundaryCondition="false" constant="false">
    <notes>
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    </notes>
   </species>
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boundaryCondition="false" constant="false">
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     CHARGE: 0
     </body>
    </notes>
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</species>
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boundaryCondition="false" constant="false">
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constant="false">
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    </notes>
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constant="false">
    <notes>
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      FORMULA: H2SO3
      CHARGE: 0
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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              </notes>
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boundaryCondition="false" constant="false">
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              </notes>
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boundaryCondition="false" constant="false">
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CHARGE: 0
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boundaryCondition="false" constant="false">
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    </notes>
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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    </notes>
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boundaryCondition="false" constant="false">
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    </notes>
  </species>
  <species id="M_RIBS_HCYS_c" name="S-Ribosyl-L-homocysteine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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    </notes>
  </species>
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
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     FORMULA: C5H8O4
      CHARGE: 0
    </body>
    </notes>
  </species>
  <\!\!\text{species id="M\_SAMA\_c" name="S-Adenosylmethioninamine" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
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constant="false">
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    </notes>
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  <species id="M_MTA_c" name="5&apos;-Methylthioadenosine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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constant="false">
    <notes>
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     FORMULA: C7H19N3
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CHARGE: 0
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constant="false">
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boundaryCondition="false" constant="false">
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            <species id="M_MTh_RIB1P_c" name="S-Methyl-5-thio-D-ribose 1-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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                        FORMULA: C6H13O7PS
                        CHARGE: 0
                    </body>
                </notes>
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</species>
  <species id="M MTh RIBL1P c" name="S-Methyl-5-thio-D-ribulose 1-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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     FORMULA: C6H13O7PS
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  <species id="M_4M_2OPENTN_c" name="4-Methyl-2-oxopentanoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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  </species>
  <species id="M_2K3M_BUT_c" name="3-Methyl-2-oxobutanoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H8O3
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    </body>
   </notes>
  </species>
  <species id="M_3M_2OPENTN_c" name="(S)-3-Methyl-2-oxopentanoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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<notes>
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     FORMULA: C6H10O3
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    </notes>
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boundaryCondition="false" constant="false">
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    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C12H19N4O7P2S
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_2MHYBUT_ThPP_c" name="2-Methyl-1-hydroxybutyl-ThPP" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C17H29N4O8P2S
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    </notes>
  </species>
  <species id="M_3MHYBUT_ThPP_c" name="3-Methyl-1-hydroxybutyl-ThPP" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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    <body xmlns="http://www.w3.org/1999/xhtml">
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CHARGE: 0
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   </notes>
  </species>
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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    FORMULA: C16H27N4O8P2S
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    </body>
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  </species>
  <species id="M_ENZN6_LPL_c" name="Enzyme N6-(lipoyl)lysine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
    FORMULA: C8H14NOS2R
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  </species>
  S-(2-methylpropanoyl)dihydrolipoyllysine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
constant="false">
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    <body xmlns="http://www.w3.org/1999/xhtml">
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     CHARGE: 0
    </body>
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</notes>
  </species>
  <species id="M_DHYLPL_MPROP_3MBUT_DHLPL_c" name="[Dihydrolipoyllysine-residue (2-methylpropanoyl)transferase] S-</pre>
(3-methylbutanoyl)dihydrolipoyllysine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
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  </species>
  <species id="M_DHYLPL_MPROP_2MBUT_DHLPL_c" name="[Dihydrolipoyllysine-residue (2-methylpropanoyl)transferase] S-</pre>
(2-methylbutanoyl)dihydrolipoyllysine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
constant="false">
   <notes>
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     FORMULA: C13H24NO2S2R
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_MBUTNCoA_c" name="(S)-2-Methylbutanoyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C26H44N7O17P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
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<species id="M_MBUT_ENCOA_c" name="2-Methylbut-2-enoyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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      FORMULA: C26H42N7O17P3S
      CHARGE: 0
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    </notes>
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   <species id="M_2M_PROCoA_c" name="2-Methylpropanoyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C25H42N7O17P3S
      CHARGE: 0
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    </notes>
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   <species id="M_MACRYCOA_c" name="Methylacrylyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C25H40N7O17P3S
     CHARGE: 0
     </body>
    </notes>
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   <species id="M_HY_MBUTRCoA_c" name="(S)-3-Hydroxy-2-methylbutyryl-CoA" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C26H44N7O18P3S
                    CHARGE: 0
                 </body>
             </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_HYIBUTRCoA\_c" name} = \text{"(S)-3-Hydroxyisobutyryl-CoA" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"false" name} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"
boundaryCondition="false" constant="false">
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                    FORMULA: C25H42N7O18P3S
                    CHARGE: 0
                 </body>
             </notes>
          </species>
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
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                    CHARGE: 0
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boundaryCondition="false" constant="false">
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                    FORMULA: C4H6O3
                    CHARGE: 0
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</body>
               </notes>
           </species>
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boundaryCondition="false" constant="false">
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                   <body xmlns="http://www.w3.org/1999/xhtml">
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                      CHARGE: 0
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               </notes>
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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           </species>
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boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C26H42N7O18P3S
     CHARGE: 0
    </body>
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  </species>
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boundaryCondition="false" constant="false">
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     CHARGE: 0
    </body>
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  </species>
  <species id="M_R_MMALCoA_c" name="(R)-Methylmalonyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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     CHARGE: 0
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  </species>
  <species id="M_MMALCoA_c" name="(S)-Methylmalonyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C25H40N7O19P3S
     CHARGE: 0
    </body>
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  </species>
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boundaryCondition="false" constant="false">
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     FORMULA: C7H7NO4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_UDP_ACMUR_ALA_GLU_DAPIM_c" name="UDP-N-acetylmuramoyl-L-alanyl-D-gamma-glutamyl-meso-2,6-</pre>
diaminopimelate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C35H55N7O26P2
     CHARGE: 0
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   </notes>
  </species>
  <species id="M_D_ALA_D_ALA_c" name="D-Alanyl-D-alanine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
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</body>
   </notes>
  </species>
  <species id="M_UDP_ACMUR_ALA_GLU_DAPIM_ALA_ALA_c" name="UDP-N-acetylmuramoyl-L-alanyl-D-glutamyl-6-</pre>
carboxy-L-lysyl-D-alanyl- D-alanine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
constant="false">
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  </species>
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hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
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boundaryCondition="false" constant="false">
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    <body xmlns="http://www.w3.org/1999/xhtml">
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    </body>
   </notes>
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</species>
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boundaryCondition="false" constant="false">
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boundaryCondition="false" constant="false">
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                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C7H8O7
                    CHARGE: 0
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             </notes>
          </species>
          <species id="M_2OADPA_c" name="2-Oxoadipate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
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                    CHARGE: 0
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             </notes>
          </species>
          <\!\!\text{species id="M\_HICTR\_c" name="Homoisocitrate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
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<body xmlns="http://www.w3.org/1999/xhtml">
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     CHARGE: 0
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    </notes>
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boundaryCondition="false" constant="false">
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      FORMULA: 
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    </notes>
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boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H13NO5
      CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_AC_AADP_DELPi_c" name="N2-Acetyl-L-aminoadipyl-delta-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H14NO8P
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<notes>

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CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_AC_AADP_SA_c" name="N2-Acetyl-L-aminoadipate semialdehyde" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H13NO4
     CHARGE: 0
    </body>
    </notes>
  </species>
  <\!\!\!\text{species id="M_N2AC\_L\_LYS\_c" name="N2-Acetyl-L-lysine" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H16N2O3
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_DHLPL_SUCCT_GLUTRDHLPL_c" name="[Dihydrolipoyllysine-residue succinyltransferase] S-</pre>
glutaryldihydrolipoyllysine, S-Glutaryldihydrolipoamide-E" compartment="c" hasOnlySubstanceUnits="false"
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C13H22NO4S2R
      CHARGE: 0
    </body>
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</notes>
   </species>
   <species id="M_ENZNE_DHYLPL_c" name="Enzyme N6-(dihydrolipoyl)lysine" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C8H16NOS2R
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    </body>
    </notes>
   </species>
   <species id="M_TM_AMBUTAL_c" name="4-Trimethylammoniobutanal" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H16NO
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    </body>
    </notes>
   </species>
   <species id="M_TM_AMBUTAT_c" name="4-Trimethylammoniobutanoate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C7H16NO2
     CHARGE: 0
    </body>
    </notes>
   </species>
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<species id="M_PRIB_ATP_c" name="Phosphoribosyl-ATP" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C15H25N5O20P4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M PRIB AMP c" name="Phosphoribosyl-AMP" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C15H23N5O14P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PRINS_AFORMA_PRIBS_IMDZ_CARBA_c" name="5-(5-Phospho-D-ribosylaminoformimino)-1-(5-</pre>
phosphoribosyl)- imidazole-4-carboxamide" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C15H25N5O15P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PRINSFORMA_PRIBS_IMDZ_CARBA_c" name="N-(5&apos;-Phospho-D-1&apos;-ribulosylformimino)-5-</pre>
amino-1-(5' ' -phospho-D-ribosyl)-4-imidazolecarboxamide" compartment="c" hasOnlySubstanceUnits="false"
```

boundaryCondition="false" constant="false">

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<notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C15H25N5O15P2
                 CHARGE: 0
              </body>
            </notes>
        </species>
        <\!\!\text{species id="M\_ERY\_IMDZ\_GLYCP\_c" name="D-erythro-1-(Imidazol-4-yl)glycerol 3-phosphate, D-erythro-Imidazole-glycerol 3-phosphate, D-erythro-Imidazole-
3-phosphate, D-erythro-Imidazole-glycerol phosphate" compartment="c" hasOnlySubstanceUnits="false"
boundaryCondition="false" constant="false">
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                  FORMULA: C6H11N2O6P
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              </body>
            </notes>
        </species>
        <species id="M_IMDZ_ACLP_c" name="Imidazole-acetol phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C6H9N2O5P
                 CHARGE: 0
              </body>
            </notes>
        </species>
        <species id="M_HISDPi_c" name="L-Histidinol phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
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FORMULA: C6H12N3O4P
                    CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_L_HISN_c" name="L-Histidinol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
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                   FORMULA: C6H11N3O
                   CHARGE: 0
                </body>
             </notes>
          </species>
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boundaryCondition="false" constant="false">
             <notes>
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                   FORMULA: C6H9N3O
                   CHARGE: 0
                </body>
             </notes>
          </species>
          <\!\!\text{species id="M_IMDZ\_AALD\_c" name="Imidazole-4-acetaldehyde" compartment="c" has Only Substance Units="false" and the compartment is a substance of the compartment is a su
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C5H6N2O
                   CHARGE: 0
                </body>
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</notes>
           </species>
           <species id="M_IMDZ_AC_c" name="4-Imidazoleacetate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C5H6N2O2
                      CHARGE: 0
                  </body>
               </notes>
           </species>
           <species id="M_HYPh_PYR_c" name="p-Hydroxyphenylpyruvate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C9H8O4
                      CHARGE: 0
                  </body>
               </notes>
           </species>
           <\!\!\text{species id} = \text{"M\_HY\_PhAC\_c" name} = \text{"4-Hydroxyphenylacetate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"c" hasOnlySubstanceUnits} = \text{"c" hasOnlySubstanceUnits
boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C8H8O3
                      CHARGE: 0
                  </body>
               </notes>
           </species>
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<species id="M_dHY_PhAC_c" name="3,4-Dihydroxyphenylacetate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H8O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M 2HY 5CARBMMUC SA c" name="2-Hydroxy-5-carboxymethylmuconate semialdehyde" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H8O6
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_CARBM_HYMUC_c" name="5-Carboxymethyl-2-hydroxymuconate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H8O7
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_CRBX_OHEPTEDA_c" name="5-Carboxy-2-oxohept-3-enedioate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
```

<notes>

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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H8O7
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_HYHEPTDENA_c" name="2-Hydroxyhepta-2,4-dienedioate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H8O5
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_OHEPEDA_c" name="2-Oxohept-3-enedioate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H8O5
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_PhAC_c" name="Phenylacetate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H8O2
     CHARGE: 0
```

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</body>
              </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_PhACoA\_c" name} = \text{"Phenylacetyl-CoA" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false"}
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C29H42N7O17P3S
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_PPYR_c" name="Phenylpyruvate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C9H8O3
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id="M\_PhALD\_c" name="Phenylacetaldehyde" compartment="c" has Only Substance Units="false" and the substance Uni
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: 
                     CHARGE: 0
                 </body>
              </notes>
          </species>
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<species id="M_dhPhACoA_c" name="2-(1,2-epoxy-1,2-dihydrophenyl)acetyl-CoA" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C29H38N7O18P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_dhPhAC_c" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_OPACCoA_c" name="2-oxepin-2(3H)-ylideneacetyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C29H38N7O18P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M ODHSCoASA c" name="3-oxo-5,6-dehydrosuberyl-CoA semialdehyde" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
```

<body xmlns="http://www.w3.org/1999/xhtml">

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FORMULA: C29H40N7O19P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_ODHSCoA_c" name="3-oxo-5,6-dehydrosuberyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C29H39N7O20P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_DHADPCoA_c" name="2,3-dehydroadipyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C27H37N7O19P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_HADPCoA_c" name="3-hydroxyadipyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C27H39N7O20P3S
     CHARGE: 0
    </body>
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</notes>
   </species>
   <species id="M_OADPCoA_c" name="3-oxoadipyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C27H37N7O20P3S
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_B_ALA_c" name="beta-Alanine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C3H7NO2
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_MAL\_SA\_c"}\ name=\!\!\text{"Malonate semialdehyde" compartment="c" has Only Substance Units=\!\!\text{"false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C3H4O3
      CHARGE: 0
     </body>
    </notes>
   </species>
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<species id="M_PANTA_c" name="(R)-Pantoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H12O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PANTO_c" name="(R)-Pantothenate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H17NO5
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_UDP_ACMURM_ALA_c" name="UDP-N-acetylmuramoyl-L-alanine" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C23H36N4O20P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_IPROP_MAL_c" name="(2R,3S)-3-IsopropyImalate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H12O5
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_RDHY_MBUTNA_c" name="(R)-2,3-Dihydroxy-3-methylbutanoate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H10O4
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_3HY_2M_2OBUTNA_c" name="3-Hydroxy-3-methyl-2-oxobutanoic acid" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H8O4
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_DHY_MPENTA_c" name="(R)-2,3-Dihydroxy-3-methylpentanoate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H12O4
     CHARGE: 0
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</body>
    </notes>
   </species>
   <species id="M_AC_HYBUTNA_c" name="(S)-2-Aceto-2-hydroxybutanoate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H10O4
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_S_ACLAC_c" name="(S)-2-Acetolactate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C5H8O4
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_IPRO_MAL_c" name="(2S)-2-Isopropylmalate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H12O5
      CHARGE: 0
     </body>
    </notes>
   </species>
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<species id="M_IPRO_MALE_c" name="2-Isopropylmaleate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H10O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M IPROP OSUCC c" name="(2S)-2-Isopropyl-3-oxosuccinate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H10O5
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_AC_GLUT_c" name="N-Acetyl-L-glutamate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H11NO5
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_AC_GLUTPi_c" name="N-Acetyl-L-glutamate 5-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H12NO8P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <\!\!\text{species id="M_AC\_GLUT\_SA\_c" name="N-Acetyl-L-glutamate 5-semialdehyde" compartment="c"}
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H11NO4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <\!\!\text{species id="M\_AORT\_c" name="N-Acetylornithine" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H14N2O3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GLUT_SA_c" name="L-Glutamate 5-semialdehyde" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H9NO3
     CHARGE: 0
```

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</body>
               </notes>
           </species>
           <species id="M_L_GLUT5P_c" name="L-Glutamyl 5-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C5H10NO7P
                      CHARGE: 0
                  </body>
               </notes>
           </species>
           <species id="M_UREA_c" name="Urea, Carbamide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: CH4N2O
                      CHARGE: 0
                  </body>
               </notes>
           </species>
           <\!\!\text{species id} = \text{"M\_UREA\_CARB\_c" name} = \text{"Urea-1-carboxylate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"c" hasOnlySubstanceUnits} = \text{"c" hasOnlySubstanceUn
boundaryCondition="false" constant="false">
               <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C2H4N2O3
                      CHARGE: 0
                  </body>
               </notes>
           </species>
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<species id="M_PYRR_3HY_5CARB_c" name="L-1-Pyrroline-3-hydroxy-5-carboxylate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H7NO3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M HYGLU SA c" name="L-4-Hydroxyglutamate semialdehyde" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H9NO4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_ERY_HYGLU_c" name="L-erythro-4-Hydroxyglutamate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H9NO5
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_4ABUTALD_c" name="4-Aminobutyraldehyde" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C4H9NO
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_tHY_PRO_c" name="trans-4-Hydroxy-L-proline" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C5H9NO3
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\!\text{species id} = \text{"M\_HY\_OGLUTR\_c" name} = \text{"D-4-Hydroxy-2-oxoglutarate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"c" hasOnlySubstanceUnits} = \text{"c" hasOnlySubstanceUnits}
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C5H6O6
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_AGMT_c" name="Agmatine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C5H14N4
                     CHARGE: 0
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</body>
             </notes>
         </species>
         <species id="M_DHYDO_ARAB_HEPTP_c" name="2-Dehydro-3-deoxy-D-arabino-heptonate 7-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C7H13O10P
                   CHARGE: 0
                </body>
             </notes>
         </species>
         <\!\!\text{species id} = \text{"M\_3DHYQNT\_c" name} = \text{"3-Dehydroquinate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" and the properties of the properti
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C7H10O6
                   CHARGE: 0
                </body>
             </notes>
         </species>
         <\!\!\text{species id="M\_DHY\_SHK\_c" name="3-Dehydroshikimate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C7H8O5
                   CHARGE: 0
                </body>
             </notes>
         </species>
```

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<species id="M_SHK_c" name="Shikimate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C7H10O5
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_SHKP_c" name="Shikimate 5-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C7H11O8P
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_CVP_SHK_c" name="5-O-(1-Carboxyvinyl)-3-phosphoshikimate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H13O10P
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_ANTHRL_c" name="Anthranilate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C7H7NO2
                     CHARGE: 0
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              </notes>
          </species>
          <species id="M_IND_c" name="Indole" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
              <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C8H7N
                      CHARGE: 0
                  </body>
              </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_CPhA\_dRBL5P\_c" name} = \text{"1-(2-Carboxyphenylamino)-1-deoxy-D-ribulose 5-phosphate" compartment} = \text{"c" name} = \text{"c
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
              <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C12H16NO9P
                     CHARGE: 0
                  </body>
              </notes>
          </species>
          <species id="M_5PRIBS_ANTRL_c" name="N-(5-Phospho-D-ribosyl)anthranilate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
              <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C12H16NO9P
                      CHARGE: 0
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</body>
    </notes>
   </species>
   <species id="M_PPHA_c" name="Prephenate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H10O6
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_CELBS_c" name="Cellobiose" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C12H22O11
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_ADP\_GLU\_c" name="ADP-glucose" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C16H25N5O15P2
      CHARGE: 0
     </body>
    </notes>
   </species>
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<species id="M_GLY_c" name="Glycogen" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: (C6H10O5)n
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_MALT_c" name="Maltose" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C12H22O11
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_IMALT_c" name="Isomaltose" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_AC_GLUSAP_c" name="N-Acetyl-D-glucosamine 6-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H16NO9P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_AC_AGLUCSAPi_c" name="N-Acetyl-alpha-D-glucosamine 1-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H16NO9P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GLUCSA1P_c" name="alpha-D-Glucosamine 1-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H14NO8P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_UDP_AC_MANNA_c" name="UDP-N-acetyl-D-mannosamine" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C17H27N3O17P2
     CHARGE: 0
```

```
</body>
            </notes>
         </species>
         <species id="M_UDP_AC_CARBVIN_GLUCSA_c" name="UDP-N-acetyl-3-(1-carboxyvinyl)-D-glucosamine" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C20H29N3O19P2
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_mINS3P_c" name="1D-myo-Inositol 3-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C6H13O9P
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <\!\!\text{species id="M\_GLCP\_c" name="sn-Glycerol 3-phosphate" compartment="c" has Only Substance Units="false" and the substance of the substanc
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C3H9O6P
                   CHARGE: 0
               </body>
            </notes>
         </species>
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<species id="M_I150CoA_c" name="Iso-C15:0 CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C36H60N7O17P3S1
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_AI150CoA_c" name="Anteiso-C15:0 CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C36H60N7O17P3S1
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_I160CoA_c" name="Iso-C16:0 CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C37H62N7O17P3S1
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_C160CoA_c" name="Palmitoyl-CoA (n-C16:0CoA)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C37H66N7O17P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_C161CoA_c" name="(2E)-Hexadecenoyl-CoA (n-C16:1CoA)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C37H64N7O17P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_I170CoA_c" name="Iso-C17:0 CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C38H64N7O17P3S1
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_AI171CoA_c" name="Anteiso-C17:1 CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C38H62N7O17P3S1
     CHARGE: 0
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</body>
   </notes>
  </species>
  <species id="M_GLY3P_c" name="1-Acyl-sn-glycerol 3-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H8O7PR
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PPTD_c" name="Phosphatidate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H7O8PR2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PMETHA_c" name="Phosphatidyl-N-methylethanolamine" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H14NO8PR2
     CHARGE: 0
    </body>
   </notes>
  </species>
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<species id="M_PDMETHA_c" name="phosphatidyl-N-dimethylethanolamine" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
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    </notes>
   </species>
   <species id="M_PCHOL_c" name="phosphatidylcholine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
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    </notes>
   </species>
   <species id="M_LYPCHOL_c" name="Lysophosphatidylcholine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_DAG_c" name="1,2-Diacyl-sn-glycerol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H6O5R2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PPTD_SER_c" name="Phosphatidyl-L-serine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C8H12NO10PR2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <\!\!\text{species id="M\_CDP\_DAG\_c" name="CDP-1,2-diacylglycerol" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C14H19N3O15P2R2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PGLYP_c" name="phosphatidylglycerophosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
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</body>
              </notes>
          </species>
          <species id="M_PMINS3P_c" name="1-phosphatidyl-1D-myo-inositol 3-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: 
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_DGALSCRAMD_c" name="Digalactosylceramide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C31H56NO13R
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_GALS\_CA\_c" name} = \text{"D-Galactosylceramide" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"c
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C25H46NO8R
                     CHARGE: 0
                 </body>
              </notes>
          </species>
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<species id="M_UDP_ACMUR_ALA_GLU_LYS_c" name="UDP-N-acetylmuramoyl-L-alanyl-gamma-D-glutamyl-L-lysine"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C34H55N7O24P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M UDP MURAC ALA GLU LYS ALA ALA c" name="UDPMurAc(oyl-L-Ala-D-gamma-Glu-L-Lys-D-Ala-D-Ala)"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C40H65N9O26P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_dt_pc_UNDECP_c" name="Undecaprenyl phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C55H91O4P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_MURAC_ALA_GLU_LYS_ALA_ALA_DP_UNDECP_c" name="MurAc(oyl-L-Ala-D-gamma-Glu-L-Lys-D-Ala-D-</pre>
Ala)-diphospho- undecaprenol" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
constant="false">
```

<notes>

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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C86H143N7O21P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M Undp ACMUR ALA GLU DAPIM AALA c" name="Undecaprenyl-diphospho-N-acetylmuramoyl-L-alanyl-D-</pre>
glutamyl-meso-2,6-diaminopimeloyl-D-alanyl-D-alanine" compartment="c" hasOnlySubstanceUnits="false"
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C87H143N7O23P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M Undp ACMUR ACGLSA ALA GLU LYS AALA c" name="Undecaprenyl-diphospho-N-acetylmuramoyl-(N-</pre>
acetylglucosamine)-L- alanyl-gamma-D-glutamyl-L-lysyl-D-alanyl-D-alanine, GlcNAc-(1->4)-Mur2Ac(oyl-L-Ala-gamma-D-Glu-L-
Lys-D-Ala-D-Ala)- diphosphoundecaprenol" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C94H156N8O26P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_Undp_ACMUR_ACGLSA_ALA_GLU_DAPIM_AALA_c" name="Undecaprenyl-diphospho-N-acetylmuramoyl-</pre>
(N-acetylglucosamine)-L- alanyl-D-glutamyl-meso-2,6-diaminopimeloyl-D-alanyl-D-alanine" compartment="c"
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
```

```
FORMULA: C95H156N8O28P2
                    CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_dt_pc_UNDECPPi_c" name="di-trans,poly-cis-Undecaprenyl diphosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C55H92O7P2
                   CHARGE: 0
                </body>
             </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_MGLX\_c" name} = \text{"Methylglyoxal" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" and the property of the pr
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C3H4O2
                   CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_GLUTAT_c" name="glutathione" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: 
                   CHARGE: 0
                </body>
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</notes>
   </species>
   <species id="M_LACGLUT_c" name="Lactoylglutathione" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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      FORMULA: 
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     </body>
    </notes>
   </species>
   <species id="M_ACPi_c" name="Acetyl phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H5O5P
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_ACADNA_c" name="Acetyl adenylate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C12H16N5O8P
     CHARGE: 0
     </body>
    </notes>
   </species>
```

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<species id="M_HY_AC_c" name="Glycolate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C2H4O3
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_FOR_c" name="Formate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: CH2O2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_METHF_c" name="5,10-Methenyltetrahydrofolate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C20H22N7O6
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_4HY_2OGLUTR_c" name="4-Hydroxy-2-oxoglutarate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H6O6
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_H2O2_c" name="Hydrogen peroxide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: H2O2
     CHARGE: 0
    </body>
    </notes>
  </species>
  <\!\!\text{species id="M_2P_GLYCA\_c" name="2-Phosphoglycolate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H5O6P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_2HYBUTNA_c" name="2-Hydroxybutyrate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H8O3
     CHARGE: 0
```

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</body>
              </notes>
          </species>
          <species id="M_PROP_ADNSPi_c" name="Propionyladenylate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C13H18N5O8P
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_PROP_c" name="Propanoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C3H6O2
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id="M_FOLNA\_c"}\ name="5\text{-}Formyltetra hydrofolate" compartment="c" has Only Substance Units="false" and the compartment is a substance of the compartment is a 
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C20H23N7O7
                    CHARGE: 0
                 </body>
              </notes>
          </species>
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<species id="M_ENZ_CYS_c" name="Thiamine biosynthesis intermediate 2" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H6N2O2SR2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M ENZ SLUFA CYS c" name="[Enzyme]-S-sulfanylcysteine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H6N2O2S2R2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_4A_M5PM_PYRM_c" name="4-Amino-2-methyl-5-phosphomethylpyrimidine, 4-Amino-5-phosphomethyl-2-</pre>
methylpyrimidine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H10N3O4P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_2M4A_HYMPYRMPPi_c" name="2-Methyl-4-amino-5-hydroxymethylpyrimidine diphosphate"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H11N3O7P2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_TOPYRM_c" name="Toxopyrimidine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H9N3O
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_4M_PE_THZ_c" name="4-Methyl-5-(2-phosphoethyl)-thiazole" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H10NO4PS
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_TMP_c" name="Thiamine monophosphate (TMP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C12H18N4O4PS
     CHARGE: 0
```

```
</body>
               </notes>
           </species>
           <species id="M_IMAC_c" name="2-iminoacetate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C2H2NO2
                      CHARGE: 0
                   </body>
               </notes>
           </species>
           <species id="M_dXYLL5P_c" name="1-Deoxy-D-xylulose 5-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C5H11O7P
                      CHARGE: 0
                   </body>
               </notes>
           </species>
           <\!\!\text{species id} = \text{"M\_THZ\_c" name} = \text{"Thiazole" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" boundaryCondition} = \text{"false" boundaryCondit
constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: 
                      CHARGE: 0
                   </body>
               </notes>
           </species>
```

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<species id="M_DHY_BUTNPi_c" name="3,4-Dihydroxy-2-butanone 4-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H9O6P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M DA PRIBSA PYMDN c" name="2,5-Diamino-6-(5&apos;-phosphoribosylamino)-4-pyrimidineone"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H16N5O8P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_AP_RIB_URA_c" name="5-Amino-6-(5&apos;-phosphoribosylamino)uracil" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H15N4O9P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_APRIBTA_URA_c" name="5-Amino-6-(5&apos;-phospho-D-ribitylamino)uracil" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C9H17N4O9P
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_RBFLV_c" name="Riboflavin (Vitamin B2)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C17H20N4O6
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <\!\!\text{species id="M_NC_D_RNUC\_c" name="Nicotinate D-ribonucleotide" compartment="c" has Only Substance Units="false" and the compartment is a substance of the compartment is a
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C11H15NO9P
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_CBMCo_c" name="Cobamide coenzyme" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C72H100CoN18O17P
                  CHARGE: 0
```

```
</body>
    </notes>
   </species>
   <species id="M_NIA_c" name="Nicotinate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H5NO2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PRIBS_DMBENZ_IMDZ_c" name="N1-(5-Phospho-alpha-D-ribosyl)-5,6-dimethylbenzimidazole"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C14H19N2O7P
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_5AM_RIBAM_URA_c" name="5-Amino-6-(1-D-ribitylamino)uracil" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C9H16N4O6
      CHARGE: 0
     </body>
    </notes>
   </species>
```

```
<species id="M_DM_DR_LUM_c" name="6,7-Dimethyl-8-(1-D-ribityl)lumazine" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C13H18N4O6
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M OPHY THR c" name="O-Phospho-4-hydroxy-L-threonine" compartment="c"
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H10NO7P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_HY_THR_c" name="4-Hydroxy-L-threonine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H9NO4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_RIBS_NCTA_c" name="N-Ribosylnicotinamide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C11H15N2O5
     CHARGE: 0
    </body>
    </notes>
  </species>
  <\!\!\text{species id} = \text{"M\_NAMD\_c" name} = \text{"Nicotinamide" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false"}
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H6N2O
      CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_NICRIB_c" name="Nicotinate D-ribonucleoside" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C11H14NO6
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_NMN_c" name="Nicotinamide mononucleotide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C11H15N2O8P
      CHARGE: 0
```

```
</body>
    </notes>
   </species>
   <species id="M_QA_c" name="Quinolinate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H5NO4
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_DA_NAD_c" name="Deamino-NAD+" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C21H27N6O15P2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_IMASP\_c" name="Iminoaspartate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H5NO4
     CHARGE: 0
     </body>
    </notes>
   </species>
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<species id="M_PIM_c" name="Pimelate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C7H12O4
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PIMCoA_c" name="Pimeloyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C28H46N7O19P3S
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_DTBTN_c" name="Dethiobiotin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H18N2O3
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_S_c" name="Sulfur" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_BTN_c" name="Biotin" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H16N2O3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_dADNS_c" name="5&apos;-Deoxyadenosine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H13N5O3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_BTN_AMP_c" name="Biotinyl-5&apos;-AMP" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C20H28N7O9PS
     CHARGE: 0
```

```
</body>
    </notes>
   </species>
   <species id="M_APCARB_c" name="Apo-[carboxylase]" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C7H13N3O2R2
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_OCT_ACP_c" name="Octanoyl-[acp]" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C8H15OSR
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\!\text{species id="M\_LP\_ACP\_c" name="Lipoyl-[acp]" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C8H13OS3R
      CHARGE: 0
     </body>
    </notes>
   </species>
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<species id="M_PN6_OCTLYS_c" name="Protein N6-(octanoyl)lysine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C8H16NOR
      CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_PN6_LPLYS_c" name="Protein N6-(lipoyl)lysine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C8H14NOS2R
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_APPRO_c" name="Apoprotein" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: NH2R
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ACP_c" name="Acyl-carrier protein (ACP)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: HSR
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_DHY_MBUTNA_c" name="2,3-Dihydroxy-3-methylbutanoate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H10O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_DHY_PAN_c" name="2-Dehydropantoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H10O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PPANT_c" name="(R)-4&apos;-Phosphopantothenate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H18NO8P
     CHARGE: 0
```

```
</body>
              </notes>
          </species>
          <species id="M_PPANTN_CYS_c" name="(R)-4&apos;-Phosphopantothenoyl-L-cysteine" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C12H23N2O9PS
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_PANTE4Pi\_c" name} = \text{"D-Pantetheine 4\&apos;-phosphate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"c" hasOnlySubstanceUnits} = \text{"c" hasOnlySubstanceUni
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C11H23N2O7PS
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_DPCoA_c" name="Dephospho-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C21H35N7O13P2S
                     CHARGE: 0
                 </body>
              </notes>
          </species>
```

```
<species id="M_FAPYRM_NTP_c" name="Formamidopyrimidine nucleoside triphosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H18N5O15P3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M DAPYRM NTP c" name="2,5-Diaminopyrimidine nucleoside triphosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H18N5O14P3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_DA_TPiTHY_OPENTAOPYRM_c" name="2,5-Diamino-6-(5&apos;-triphosphoryl-3&apos;,4&apos;-triphydroxy-</pre>
2'-oxopentyl)- amino-4-oxopyrimidine" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H18N5O14P3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_AHYRY_THYPROP_DHYPTRN_TPi_c" name="2-Amino-4-hydroxy-6-(erythro-1,2,3-</pre>
trihydroxypropyl)dihydropteridine triphosphate" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"
```

constant="false">

```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H16N5O13P3
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_DHY_NPTRN_c" name="Dihydroneopterin, 7,8-Dihydroneopterin" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C9H13N5O4
      CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_GLYCALD_c" name="Glycolaldehyde" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H4O2
      CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_AHY_HYM_DHYPTR_c" name="2-Amino-4-hydroxy-6-hydroxymethyl-7,8-dihydropteridine"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H9N5O2
```

<notes>

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CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ADHY_DPOM_PTRDN_c" name="2-Amino-7,8-dihydro-4-hydroxy-6-(diphosphooxymethyl)pteridine"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H11N5O8P2
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ABEE_c" name="p-Aminobenzoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H7NO2
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_DHY_PTR_c" name="Dihydropteroate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C14H14N6O3
     CHARGE: 0
    </body>
    </notes>
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</species>
  <species id="M_THF_GLUT_c" name="THF-L-glutamate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C24H30N8O9
      CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_DHF_c" name="Dihydrofolate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C19H21N7O6
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_MEROLPi_c" name="2-C-Methyl-D-erythritol 4-phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H13O7P
      CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_CYTPPi_MEROL_c" name="4-(Cytidine 5&apos;-diphospho)-2-C-methyl-D-erythritol" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
```

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<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C14H25N3O14P2
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_PCYTPPi_MEROL_c" name="2-Phospho-4-(cytidine 5&apos;-diphospho)-2-C-methyl-D-erythritol"</pre>
compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C14H26N3O17P3
      CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_MEROL_CYCPPi_c" name="2-C-Methyl-D-erythritol 2,4-cyclodiphosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C5H12O9P2
      CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_R_FRDX_c" name="Reduced ferredoxin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA:
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CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_HY_MBUTEPPi_c" name="1-Hydroxy-2-methyl-2-butenyl 4-diphosphate; (E)-4-Hydroxy-3-methyl-but-2-enyl</pre>
diphosphate; (E)-4-Hydroxy-3-methylbut-2-en-1-yl diphosphate" compartment="c" hasOnlySubstanceUnits="false"
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C5H12O8P2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_O_FRDX_c" name="Oxidized ferredoxin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_DMAPP_c" name="Dimethylallyl diphosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C5H12O7P2
      CHARGE: 0
     </body>
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</notes>
   </species>
   <species id="M_GRN_PPi_c" name="Geranyl diphosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C10H20O7P2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_FAR_PPi_c" name="trans,trans-Farnesyl diphosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C15H28O7P2
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_GRN_GRNPPi_c" name="Geranylgeranyl diphosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C20H36O7P2
     CHARGE: 0
     </body>
    </notes>
   </species>
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<species id="M_CRVN_c" name="(+)-(S)-Carvone" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C10H14O
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_IDHY_CRVN_c" name=" (1R,4S)-Iso-dihydrocarvone" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C10H16O
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_PHTEN_c" name="Phytoene" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C40H64
     CHARGE: 0
    </body>
    </notes>
  </species>
  <\!\!\text{species id="M\_PHFLN\_c" name="Phytofluene" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C40H62
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_NRSPENE_c" name="Neurosporene" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C40H58
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_LCPN_c" name="Lycopene" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C40H56
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ENITRN_c" name="Ethylnitronate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H4NO2
     CHARGE: 0
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</body>
    </notes>
   </species>
   <species id="M_NO2_c" name="Nitrite" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: HNO2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PAPS_c" name="3&apos;-Phosphoadenylyl sulfate (PAPS)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C10H15N5O13P2S
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PAP_c" name="Phosphoadenosine phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H15N5O10P2
      CHARGE: 0
     </body>
    </notes>
   </species>
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<species id="M_CYSTHN_c" name="Cystathionine" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C7H14N2O4S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M H4MPT c" name="5,6,7,8-Tetrahydromethanopterin (H4MPT)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C30H45N6O16P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_METHMPTR_c" name="5,10-Methylenetetrahydromethanopterin" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C31H45N6O16P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PSULFLAC_c" name="(2R)-O-Phospho-3-sulfolactate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C3H7O9PS
                  CHARGE: 0
                </body>
             </notes>
         </species>
         <species id="M_SULFLAC_c" name="(2R)-3-Sulfolactate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C3H6O6S
                   CHARGE: 0
                </body>
             </notes>
         </species>
         <\!\!\!\text{species id="M\_UPPHYRGN\_I\_c" name="Uroporphyrinogen I" compartment="c" has Only Substance Units="false" and the property of the propert
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: C40H44N4O16
                  CHARGE: 0
                </body>
             </notes>
         </species>
         <species id="M_CPPHYRGN_I_c" name="Coproporphyrinogen I" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C36H44N4O8
                   CHARGE: 0
```

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</body>
              </notes>
          </species>
          <species id="M_UPPHYRGN_III_c" name="Uroporphyrinogen III" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C40H44N4O16
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_CPPPHYRGN_c" name="Coproporphyrinogen III" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C36H44N4O8
                    CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_ALEVU\_c" name} = \text{"5-Aminolevulinate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" and the property of t
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C5H9NO3
                    CHARGE: 0
                 </body>
              </notes>
          </species>
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<species id="M_PPBLGN_c" name="Porphobilinogen" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H14N2O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_HY_MBILN_c" name="Hydroxymethylbilane" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C40H46N4O17
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PPPHYRGN_c" name="Protoporphyrinogen IX" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C34H40N4O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PPPHYR_c" name="Protoporphyrin IX" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C34H34N4O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_Fe2_c" name="Ferrous ion" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: Fe
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_HEME_c" name="Heme" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C34H32FeN4O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GLU_SA_c" name="L-Glutamate 1-semialdehyde" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H9NO3
     CHARGE: 0
```

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</body>
    </notes>
   </species>
   <species id="M_PRCRN_c" name="Precorrin 2" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C42H48N4O16
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_Mg_c" name="Magnesium" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: Mg
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_Mg_PPPHYR_c" name="Magnesium protoporphyrin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C34H32MgN4O4
      CHARGE: 0
    </body>
    </notes>
   </species>
```

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<species id="M_HEMO_c" name="Heme O" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C49H58FeN4O5
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_SRHYCLR_c" name="Sirohydrochlorin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C42H46N4O16
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_SHEME_c" name="Siroheme" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C42H44FeN4O16
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PRCRN3A_c" name="Precorrin 3A" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C43H50N4O16
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_CoSRHYCLR_c" name="Cobalt-sirohydrochlorin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C42H44CoN4O16
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_CoFIII_c" name="Cobalt-factor III" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C43H46CoN4O16
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_CoPRCRN3_c" name="Cobalt-precorrin 3" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C43H48CoN4O16
     CHARGE: 0
```

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</body>
    </notes>
   </species>
   <species id="M_CoPRCRN4_c" name="Cobalt-precorrin 4" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C44H50CoN4O16
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_PRCRN3B_c" name="Precorrin 3B" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C43H50N4O17
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_PRCRN4_c" name="Precorrin 4" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C44H52N4O17
      CHARGE: 0
    </body>
    </notes>
   </species>
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<species id="M_PRCRN5_c" name="Precorrin 5" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C45H54N4O17
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_CoPRCRN5A_c" name="Cobalt-precorrin 5A" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C45H52CoN4O16
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PRCRN6B_c" name="Precorrin 6B" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C44H56N4O16
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PRCRN8X_c" name="Precorrin 8" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C45H60N4O14
                    CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_HOBYRNA_c" name="Hydrogenobyrinate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C45H60N4O14
                    CHARGE: 0
                </body>
             </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_CoPRCRN8\_c" name} = \text{"Cobalt-precorrin 8" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"cobalt-precorrin 8" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"cobalt-precorrin 8" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" name} = \text{"cobalt-precorrin 8" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"c" hasOnlySubstanceUnit
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C45H59CoN4O14
                    CHARGE: 0
                </body>
             </notes>
          </species>
          <species id="M_CBRYNA_c" name="Cobyrinate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C45H59CoN4O14
                    CHARGE: 0
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</body>
   </notes>
  </species>
  <species id="M_HOBYRNDA_c" name="Hydrogenobyrinate diamide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C45H62N6O12
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_Co2ABYRDA_c" name="Cob(II)yrinate diamide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C45H61CoN6O12
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_ADNS_CABYRDA_c" name="Adenosyl cobyrinate diamide" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C55H73CoN11O15
     CHARGE: 0
    </body>
   </notes>
  </species>
```

```
<species id="M_ADNS_CABYRHA_c" name="Adenosyl cobyrinate hexaamide" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C55H77CoN15O11
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_CO_LPAREN_II_RPAREN_c" name="Cobalt" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_CABYRDA_c" name="Cob(I)yrinate diamide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C45H61CoN6O12
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id} = \text{"M\_CBAMD\_c" name} = \text{"Cobinamide" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false"}
boundaryCondition="false" constant="false">
    <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C48H72CoN11O8
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ADNS_CBNA_c" name="Adenosyl cobinamide" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C58H84CoN16O11
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_APRNPi_c" name="D-1-Aminopropan-2-ol O-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H10NO4P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ADNS_CBNAPi_c" name="Adenosyl cobinamide phosphate" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C58H85CoN16O14P
     CHARGE: 0
```

```
</body>
             </notes>
          </species>
          <species id="M_ADNS_CBNA_GDP_c" name="Adenosine-GDP-cobinamide" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
             <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C68H97CoN21O21P2
                    CHARGE: 0
                 </body>
             </notes>
          </species>
          <species id="M_ARIBZ_c" name="alpha-Ribazole" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
             <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C14H18N2O4
                    CHARGE: 0
                 </body>
             </notes>
          </species>
          <\!\!\text{species id="M\_TRE\_c" name="Trehalose" compartment="c" has Only Substance Units="false" boundary Condition="false" and the substance Units="false" boundary Condition="false" boundary Condition="fals
constant="false">
             <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                    FORMULA: C12H22O11
                    CHARGE: 0
                 </body>
             </notes>
          </species>
```

```
<species id="M_TRE6P_c" name="Trehalose 6-phosphate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C12H23O14P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_IVCoA_c" name="Isovaleryl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C26H44N7O17P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_MCROCoA_c" name="3-Methylcrotonyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C26H42N7O17P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_3MGLUTNCoA_c" name="3-Methylglutaconyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C27H42N7O19P3S
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_ACACoA_c" name="Acetoacetyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C25H40N7O18P3S
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_MQL_c" name="Menaquinol" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C16H18O2(C5H8)n
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_A_PROPOL_c" name="(R)-1-Amino-2-propanol" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H9NO
     CHARGE: 0
```

```
</body>
    </notes>
   </species>
   <species id="M_4A4CORM_c" name="(2S)-2-Amino-4-deoxychorismate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C10H11NO5
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_MALYCoA_c" name="(3S)-3-carboxy-3-hydroxypropionyl-CoA" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C25H40N7O20P3S
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_Al171_c" name="14-Methyl-hexadecenoate (anteiso-17:1)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
      CHARGE: 0
     </body>
    </notes>
   </species>
```

```
<species id="M_Al150_c" name="12-Methyl-tetradecanoate (anteiso-15:0)" compartment="c"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
     </body>
    </notes>
  </species>
  <species id="M_I150_c" name="13-Methyltetradecanoate (iso-15:0)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
     </body>
    </notes>
  </species>
  <species id="M_I160_c" name="14-Methylpentadecanoate (iso-16:0)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
     </body>
    </notes>
  </species>
  <\!\!\text{species id="M_I170\_c" name="15-Methyl hexadecenoate (iso-17:0)" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_I130_c" name="11-Methyldodecanoate (iso-13:0)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_I110_c" name="9-methyldecanoate (iso-11:0)" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_C160_c" name="Hexadecanoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C16H32O2
     CHARGE: 0
```

```
</body>
    </notes>
   </species>
   <species id="M_C161_c" name="Palmitoleate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C16H30O2
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\!\text{species id="M_gCARO\_c" name="gamma-Carotene" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C40H56
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_bCARO\_c" name="beta-Carotene" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C40H56
      CHARGE: 0
     </body>
    </notes>
   </species>
```

```
<species id="M_CRTX_c" name="beta-Cryptoxanthin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C40H56O
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_ZXT_c" name="Zeaxanthin" compartment="c" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C40H56O2
     CHARGE: 0
    </body>
   </notes>
  </species>
  boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C57H86O7
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_bCRTX_GLU_c" name="beta-Cryptoxanthin glucoside" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: 
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_ZXT_GLU_c" name="Zeaxanthin glucoside" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: 
                   CHARGE: 0
               </body>
            </notes>
         </species>
         <\!\!\text{species id="M_tZXT\_GLU\_c" name="Thermozeaxanthin glucoside" compartment="c" has Only Substance Units="false" and the substance of the s
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: 
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_tbZXT_c" name="Thermobiszeaxanthin" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C78H124O14
                   CHARGE: 0
```

```
</body>
   </notes>
  </species>
  <species id="M_RHY_BUTCoA_c" name="(R)-3-Hydroxybutanoyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C25H42N7O18P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_KVCoA_c" name="beta-ketovaleryl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C26H38N7O18P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_HVCoA_c" name="(R)-3-hydroxyvaleryl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C26H40N7O18P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
```

```
<species id="M_PHB_c" name="Polyhydroxybutyrate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_PHV_c" name="Polyhydroxyvalerate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: 
      CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_HY_OCTCoA_c" name="(S)-3-Hydroxyoctanoyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C29H50N7O18P3S
      CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M\_PHO\_c" name="Polyhydroxyoctanoate" compartment="c" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
    <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_HY_DECCoA_c" name="(S)-3-Hydroxydecanoyl-CoA" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C31H54N7O18P3S
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_PHD_c" name="Polyhydroxydecanoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_HY_DODECCoA_c" name="(S)-3-Hydroxydodecanoyl-CoA" compartment="c"
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C33H58N7O18P3S
     CHARGE: 0
```

```
</body>
               </notes>
           </species>
           <species id="M_PHDD_c" name="Polyhydodroxydecanoate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: 
                      CHARGE: 0
                   </body>
               </notes>
           </species>
           <species id="M_GLCN_c" name="D-Gluconate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                       FORMULA: C6H12O7
                      CHARGE: 0
                   </body>
               </notes>
           </species>
           <\!\!\text{species id} = \text{"M\_GLCN6P\_c" name} = \text{"6-Phospho-D-gluconate" compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"false" long to the compartment} = \text{"c" hasOnlySubstanceUnits} = \text{"c
boundaryCondition="false" constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C6H13O10P
                       CHARGE: 0
                   </body>
               </notes>
           </species>
```

```
<species id="M_DHYGLCN_c" name="5-Dehydro-D-gluconate" compartment="c" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C6H10O7
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_D_GLC_e" name="D-Glucose" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C6H12O6
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_H2O_e" name="Water" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: H2O
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_O2_e" name="Oxygen" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
```

<notes>

```
<body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: O2
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_SO4\_e" name} = \text{"Sulfate" compartment} = \text{"e" hasOnlySubstanceUnits} = \text{"false" boundaryCondition} = \text{"false" boundaryConditi
constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: H2SO4
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id="M\_Pi\_e" name="Orthophosphate" compartment="e" has Only Substance Units="false"}
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: H3PO4
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <species id="M_CO2_e" name="Carbon dioxide" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: CO2
                     CHARGE: 0
```

```
</body>
               </notes>
           </species>
           <species id="M_AC_e" name="Acetate" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C2H4O2
                      CHARGE: 0
                   </body>
               </notes>
           </species>
           <species id="M_D_ALA_D_ALA_e" name="D-Alanyl-D-alanine" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C6H12N2O3
                      CHARGE: 0
                   </body>
               </notes>
           </species>
           <\!\!\text{species id} = \text{"M\_L\_ARG\_e" name} = \text{"L-Arginine" compartment} = \text{"e" hasOnlySubstanceUnits} = \text{"false" boundaryCondition} = \text{"false" boundaryCo
constant="false">
               <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C6H14N4O2
                      CHARGE: 0
                   </body>
               </notes>
           </species>
```

```
<species id="M_L_ASN_e" name="L-Asparagine" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H8N2O3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_CIT_e" name="Citrate" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H8O7
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_ETH_e" name="Ethanol" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H6O
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_F1P_e" name="D-Fructose 1-phosphate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O9P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_FUCL1P_e" name="L-Fuculose 1-phosphate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O8P
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_Fe2_e" name="Ferrous ion" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: Fe
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_D_FRU_e" name="D-Fructose" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H12O6
     CHARGE: 0
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</body>
    </notes>
   </species>
   <species id="M_FUM_e" name="Fumarate" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H4O4
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_GLUCSA1P_e" name="alpha-D-Glucosamine 1-phosphate" compartment="e"</pre>
hasOnlySubstanceUnits="false" boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C6H14NO8P
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_GLUSAP_e" name="D-Glucosamine 6-phosphate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H14NO8P
      CHARGE: 0
    </body>
    </notes>
   </species>
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<species id="M_GLYCALD_e" name="Glycolaldehyde" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H4O2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_D_GLU_e" name="D-Glutamate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H9NO4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_HY_AC_e" name="Glycolate" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H4O3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_D_GLCT_e" name="D-Glycerate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H6O4
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_GLYCRL_e" name="Glycerol" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H8O3
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_L_GLY_e" name="Glycine" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C2H5NO2
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_H2S_e" name="Hydrogen sulfide" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: H2S
     CHARGE: 0
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</body>
                          </notes>
                   </species>
                   <species id="M_L_HCYS_e" name="L-Homocysteine" compartment="e" hasOnlySubstanceUnits="false"</pre>
 boundaryCondition="false" constant="false">
                          <notes>
                                <body xmlns="http://www.w3.org/1999/xhtml">
                                     FORMULA: C4H9NO2S
                                     CHARGE: 0
                                </body>
                          </notes>
                   </species>
                   <\!\!\text{species id} = \text{"M\_L\_ILE\_e" name} = \text{"L-Isoleucine" compartment} = \text{"e" hasOnlySubstanceUnits} = \text{"false" and the property of the pr
boundaryCondition="false" constant="false">
                          <notes>
                                <body xmlns="http://www.w3.org/1999/xhtml">
                                     FORMULA: C6H13NO2
                                     CHARGE: 0
                                </body>
                          </notes>
                   </species>
                   <\!\!\text{species id} = \text{"M\_L\_LYS\_e" name} = \text{"L-Lysine" compartment} = \text{"e" hasOnlySubstanceUnits} = \text{"false" boundaryCondition} = \text{"false" boundaryCond
constant="false">
                          <notes>
                                <body xmlns="http://www.w3.org/1999/xhtml">
                                     FORMULA: C6H14N2O2
                                     CHARGE: 0
                                </body>
                          </notes>
                   </species>
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<species id="M_MAL_e" name="L-Malate" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C4H6O5
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_MALT_e" name="Maltose" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C12H22O11
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_IMALT_e" name="Isomaltose" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_MAN1P_e" name="D-Mannose 1-phosphate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O9P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_M6P_e" name="D-Mannose 6-phosphate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H13O9P
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_D_MAN_e" name="D-Mannose" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H12O6
     CHARGE: 0
    </body>
   </notes>
  </species>
  <species id="M_L_PHE_e" name="L-Phenylalanine" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C9H11NO2
     CHARGE: 0
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</body>
    </notes>
   </species>
   <species id="M_L_PRO_e" name="L-Proline" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H9NO2
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_D_RIB_e" name="D-Ribose" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H10O5
     CHARGE: 0
    </body>
    </notes>
   </species>
   <species id="M_SORB_e" name="D-Sorbitol" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H14O6
     CHARGE: 0
    </body>
    </notes>
   </species>
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<species id="M_L_SER_e" name="L-Serine" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
              <notes>
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                     FORMULA: C3H7NO3
                     CHARGE: 0
                  </body>
              </notes>
          </species>
          <species id="M_SO3_e" name="Sulfite" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
              <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: H2SO3
                     CHARGE: 0
                  </body>
              </notes>
          </species>
          <species id="M_SUCC_e" name="Succinate" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
              <notes>
                  <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: C4H6O4
                     CHARGE: 0
                  </body>
              </notes>
          </species>
          <\!\!\text{species id} = \text{"M\_SUC\_e" name} = \text{"Sucrose" compartment} = \text{"e" hasOnlySubstanceUnits} = \text{"false" boundaryCondition} = \text{"false" boundaryConditi
constant="false">
              <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C12H22O11
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_L_ALA_e" name="L-Alanine" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H7NO2
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_L_ASP_e" name="L-Aspartate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H7NO4
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_L_CYS_e" name="L-Cysteine" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H7NO2S
     CHARGE: 0
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</body>
    </notes>
   </species>
   <species id="M_L_GLU_e" name="L-Glutamate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H9NO4
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_L_MET_e" name="L-Methionine" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C5H11NO2S
     CHARGE: 0
     </body>
    </notes>
   </species>
   <\!\!\text{species id="M_L_THR}\_e"\,name="\text{L-Threonine"}\,compartment="e"\,hasOnlySubstanceUnits="false"
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C4H9NO3
     CHARGE: 0
     </body>
    </notes>
   </species>
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<species id="M_L_LEU_e" name="L-Leucine" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C6H13NO2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_L_TRP_e" name="L-Tryptophan" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
      FORMULA: C11H12N2O2
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_L_TYR_e" name="L-Tyrosine" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
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     FORMULA: C9H11NO3
     CHARGE: 0
     </body>
    </notes>
   </species>
   <species id="M_L_VAL_e" name="L-Valine" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C5H11NO2
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_HCO3_e" name="Bicarbonate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: HCO3
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_LAC_e" name="L-Lactate" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C3H6O3
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_NH4_e" name="Ammonia" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: NH4
     CHARGE: 0
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</body>
                </notes>
           </species>
           <species id="M_TRE_e" name="Trehalose" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
                <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C12H22O11
                      CHARGE: 0
                   </body>
                </notes>
           </species>
           <species id="M_Mg_e" name="Magnesium" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
                <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: Mg
                      CHARGE: 0
                   </body>
                </notes>
           </species>
           <\!\!\text{species id} = \text{"M\_HEME\_e" name} = \text{"Heme" compartment} = \text{"e" hasOnlySubstanceUnits} = \text{"false" boundaryCondition} = \text{"false" boundaryCondition
constant="false">
                <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                      FORMULA: C34H32FeN4O4
                      CHARGE: 0
                   </body>
                </notes>
           </species>
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<species id="M_GLCN_e" name="D-Gluconate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
            <notes>
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                   FORMULA: C6H12O7
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_CELBS_e" name="Cellobiose" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                   FORMULA: C12H22O11
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <species id="M_PALT_e" name="Paltinose" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  FORMULA: 
                  CHARGE: 0
               </body>
            </notes>
         </species>
         <\!\!\text{species id="M\_D\_GAL\_e" name="D-Galactose" compartment="e" has Only Substance Units="false" and the compartment of the co
boundaryCondition="false" constant="false">
            <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: C6H12O6
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_LACTS_e" name="Lactose" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_STCYS_e" name="Stachyose" compartment="e" hasOnlySubstanceUnits="false" boundaryCondition="false"</pre>
constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
    </body>
    </notes>
  </species>
  <species id="M_PHB_e" name="polyhydroxybutyrate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     FORMULA: 
     CHARGE: 0
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</body>
              </notes>
          </species>
          <species id="M_PHV_e" name="Polyhydroxyvalerate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
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                     FORMULA: 
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                 </body>
              </notes>
          </species>
          <species id="M_PHO_e" name="Polyhydroxyoctanoate" compartment="e" hasOnlySubstanceUnits="false"</pre>
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: 
                     CHARGE: 0
                 </body>
              </notes>
          </species>
          <\!\!\text{species id="M\_PHD\_e" name="Polyhydroxydecanoate" compartment="e" has Only Substance Units="false" and the substance of the substance of
boundaryCondition="false" constant="false">
              <notes>
                 <body xmlns="http://www.w3.org/1999/xhtml">
                     FORMULA: 
                     CHARGE: 0
                 </body>
              </notes>
          </species>
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<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
   FORMULA: 
   CHARGE: 0
  </body>
 </notes>
</species>
</listOfSpecies>
distOfReactions>
<reaction id="R_R001" name="Biomass reaction (70 C)" reversible="false">
 <notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Exchange Reactions
   EC Number: 
   Confidence Level: 1
   AUTHORS: 
   </body>
 </notes>
 listOfReactants>
  <speciesReference species="M_L_ASP_c" stoichiometry="0.1582"/>
  <speciesReference species="M_L_GLU_c" stoichiometry="0.2696"/>
  <speciesReference species="M L SER c" stoichiometry="0.2076"/>
  <speciesReference species="M_L_HIS_c" stoichiometry="0.0375"/>
  <speciesReference species="M_L_GLY_c" stoichiometry="0.4716"/>
  <speciesReference species="M_L_THR_c" stoichiometry="0.1531"/>
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<speciesReference species="M_L_ARG_c" stoichiometry="0.3231"/>
<speciesReference species="M L ALA c" stoichiometry="0.5434"/>
<speciesReference species="M_L_TYR_c" stoichiometry="0.1052"/>
<speciesReference species="M_L_VAL_c" stoichiometry="0.1668"/>
<speciesReference species="M_L_PHE_c" stoichiometry="0.1322"/>
<speciesReference species="M_L_ILE_c" stoichiometry="0.0593"/>
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<speciesReference species="M_L_LYS_c" stoichiometry="0.1337"/>
<speciesReference species="M_L_PRO_c" stoichiometry="0.2898"/>
<speciesReference species="M_L_ASN_c" stoichiometry="0.1582"/>
<speciesReference species="M_L_CYS_c" stoichiometry="0.0134"/>
<speciesReference species="M_L_GLN_c" stoichiometry="0.2714"/>
<speciesReference species="M_L_MET_c" stoichiometry="0.0224"/>
<speciesReference species="M_L_TRP_c" stoichiometry="0.0654"/>
<speciesReference species="M_UDP_ACMURM_c" stoichiometry="0.011"/>
<speciesReference species="M_UDP_AGLUAM_c" stoichiometry="0.011"/>
<speciesReference species="M_D_GLU_c" stoichiometry="0.011"/>
<speciesReference species="M_ORT_c" stoichiometry="0.011"/>
<speciesReference species="M D ALA c" stoichiometry="0.0259"/>
<speciesReference species="M_dTTP_c" stoichiometry="0.0098"/>
<speciesReference species="M_dGTP_c" stoichiometry="0.0223"/>
<speciesReference species="M_dCTP_c" stoichiometry="0.0223"/>
<speciesReference species="M_dATP_c" stoichiometry="0.0098"/>
<speciesReference species="M_CTP_c" stoichiometry="0.0586"/>
<speciesReference species="M_GTP_c" stoichiometry="0.1455"/>
<speciesReference species="M_UTP_c" stoichiometry="0.0976"/>
<speciesReference species="M_MGDG_c" stoichiometry="0.01095"/>
<speciesReference species="M DGDG c" stoichiometry="0.0091"/>
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<speciesReference species="M_PETHA_c" stoichiometry="0.0031"/>
  <speciesReference species="M PGLY c" stoichiometry="0.0022"/>
  <speciesReference species="M_PINS_c" stoichiometry="0.0066"/>
  <speciesReference species="M_CDLPN_c" stoichiometry="0.0012"/>
  <speciesReference species="M_PX_c" stoichiometry="0.0404"/>
  <speciesReference species="M_ATP_c" stoichiometry="59.81"/>
 </listOfReactants>
 distOfProducts>
  <speciesReference species="M_ADP_c" stoichiometry="59.81"/>
  <speciesReference species="M_Pi_c" stoichiometry="59.81"/>
  <speciesReference species="M_PPi_c" stoichiometry="0.3659"/>
 </listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
  distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="1" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R002" name="ATP Maintenance" reversible="false">
 <notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Uassigned
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EC Number: 
         Confidence Level: 1
         AUTHORS: 
         </body>
   </notes>
   listOfReactants>
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     <speciesReference species="M_H2O_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="14.29" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R003" name="ATP:D-glucose 6-phosphotransferase" reversible="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC1688
     SUBSYSTEM: Glycolysis/Gluconeogenesis
     EC Number: 2.7.1.2
     Confidence Level: 1
     AUTHORS: Carbohydrate metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M D GLC c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_ADP_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_G6P_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
</kineticLaw>
```

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</reaction>
<reaction id="R R004" name="ATP:D-glucose 6-phosphotransferase" reversible="false">
 <notes>
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  GENE_ASSOCIATION: TTC1688
  SUBSYSTEM: Glycolysis/Gluconeogenesis
  EC Number: 2.7.1.2
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_D_MAN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_M6P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
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  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

```
<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R005" name="D-glucose-6-phosphate aldose-ketose-isomerase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1710
  SUBSYSTEM: Glycolysis/Gluconeogenesis
  EC Number: 5.3.1.9
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_G6P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_F6P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R006" name="ATP:D-fructose-6-phosphate 1-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1597
   SUBSYSTEM: Glycolysis/Gluconeogenesis
   EC Number: 2.7.1.11
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_F6P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_FBP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  forming)" reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1414
     SUBSYSTEM: Glycolysis/Gluconeogenesis
     EC Number: 4.1.2.13
     Confidence Level: 1
     AUTHORS: Carbohydrate metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_FBP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_DHAP_c" stoichiometry="1"/>
    <speciesReference species="M_GAP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
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distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R008" name="D-glyceraldehyde-3-phosphate aldose-ketose-isomerase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0581
  SUBSYSTEM: Glycolysis/Gluconeogenesis
  EC Number: 5.3.1.1
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 <speciesReference species="M_GAP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_DHAP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
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distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R009" name="D-glyceraldehyde-3-phosphate:NAD+ oxidoreductase (phosphorylating)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0549
   SUBSYSTEM: Glycolysis/Gluconeogenesis
   EC Number: 1.2.1.12
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
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 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_GAP_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M 13BPG c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R010" name="ATP:3-phospho-D-glycerate 1-phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0550
  SUBSYSTEM: Glycolysis/Gluconeogenesis
  EC Number: 2.7.2.3
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_3PG_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M 13BPG c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R011" name="2-Phospho-D-glycerate 2,3-phosphomutase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC1888 or TTC1618 or TTC1956 or TT P0006)
   SUBSYSTEM: Glycolysis/Gluconeogenesis
   EC Number: 5.4.2.1
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M 2PG c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
 <speciesReference species="M 3PG c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R012" name="2-phospho-D-glycerate hydro-lyase (phosphoenolpyruvate-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1610
   SUBSYSTEM: Glycolysis/Gluconeogenesis
   EC Number: 4.2.1.11
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_PEP_c" stoichiometry="1"/>
```

```
</listOfReactants>
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     <speciesReference species="M_2PG_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R013" name="ATP:pyruvate 2-O-phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC1611
         SUBSYSTEM: Glycolysis/Gluconeogenesis
         EC Number: 2.7.1.40
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
```

```
<speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M PEP c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_PYR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R014" name="ATP:oxaloacetate carboxy-lyase (transphosphorylating;phosphoenolpyruvate-forming)"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1709
     SUBSYSTEM: Glycolysis/Gluconeogenesis
     EC Number: 4.1.1.49
     Confidence Level: 1
     AUTHORS: Carbohydrate metabolism
```

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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
     <speciesReference species="M_OAC_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_PEP_c" stoichiometry="1"/>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     defined and the control of t
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R015" name="(S)-Lactate:NAD+ oxidoreductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0748
        SUBSYSTEM: Glycolysis/Gluconeogenesis
        EC Number: 1.1.1.27
```

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Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_LAC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R016" name="Acetate:CoA ligase (AMP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

```
GENE_ASSOCIATION: (TTC0884 and TTC0885 and TTC0886 and TTC0919)
     SUBSYSTEM: Glycolysis/Gluconeogenesis
     EC Number: 6.2.1.1
     Confidence Level: 1
     AUTHORS: Carbohydrate metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_CoA_c" stoichiometry="1"/>
  <speciesReference species="M AC c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_AMP_c" stoichiometry="1"/>
  <speciesReference species="M_ACoA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R017" name="Acetaldehyde:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0513 or TTC0604)
  SUBSYSTEM: Glycolysis/Gluconeogenesis
  EC Number: 1.2.1.3
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_AALD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M H c" stoichiometry="2"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

```
<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R018" name="ethanol:NAD+ oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1572
   SUBSYSTEM: Glycolysis/Gluconeogenesis
   EC Number: 1.1.1.1
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_ETH_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_AALD_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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```
<parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R019" name="acetyl-CoA:oxaloacetate C-acetyltransferase (thioester-hydrolysing)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0978
   SUBSYSTEM: Citric Acid Cycle
   EC Number: 2.3.3.1
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_OAC_c" stoichiometry="1"/>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M CIT c" stoichiometry="1"/>
 </listOfProducts>
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<listOfParameters>

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<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R020" name="citrate hydro-lyase (cis-aconitate-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0374
   SUBSYSTEM: Citric Acid Cycle
   EC Number: 4.2.1.3
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_CIT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_cACO_c" stoichiometry="1"/>
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```
</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R021" name="isocitrate hydro-lyase (cis-aconitate-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0374
   SUBSYSTEM: Citric Acid Cycle
   EC Number: 4.2.1.3
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ICIT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
```

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<speciesReference species="M_cACO_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R022" name="Isocitrate:NADP+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1172
   SUBSYSTEM: Citric Acid Cycle
   EC Number: 1.1.1.42
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ICIT_c" stoichiometry="1"/>
 <speciesReference species="M NADP c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_OXLSUCC_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R023" name="oxalosuccinate carboxy-lyase (2-oxoglutarate-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1172
   SUBSYSTEM: Citric Acid Cycle
   EC Number: 1.1.1.42
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M OXLSUCC c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_AKG_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R024" name="2-oxoglutarate:ferredoxin oxidoreductase (decarboxylating)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC1591 and TTC1592)
        SUBSYSTEM: Citric Acid Cycle
        EC Number: 1.2.7.3
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
```

```
</notes>
   distOfReactants>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_CoA_c" stoichiometry="1"/>
     <speciesReference species="M_AKG_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_SUCCoA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R025" name="Succinate:CoA ligase (ADP-forming)" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0169 and TTC0170)
        SUBSYSTEM: Citric Acid Cycle
        EC Number: 6.2.1.5
```

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Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
     <speciesReference species="M_CoA_c" stoichiometry="1"/>
     <speciesReference species="M_SUCC_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_SUCCoA_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R026" name="Succinate:(acceptor) oxidoreductase" reversible="true">
   <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: (TTC1089 and TTC1090 and TTC1091 and TTC1092)
  SUBSYSTEM: Citric Acid Cycle
  EC Number: 1.3.99.1
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SUCC_c" stoichiometry="1"/>
 <speciesReference species="M FAD c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_FADH2_c" stoichiometry="1"/>
 <speciesReference species="M_FUM_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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```
<reaction id="R_R027" name="(S)-malate hydro-lyase (fumarate-forming)" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0190
        SUBSYSTEM: Citric Acid Cycle
        EC Number: 4.2.1.2
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_MAL_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_FUM_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R028" name="(S)-malate:NAD+ oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0168
  SUBSYSTEM: Citric Acid Cycle
  EC Number: 1.1.1.37
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_MAL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M NADH c" stoichiometry="1"/>
 <speciesReference species="M_OAC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R029" name="D-glucose:ubiquinone oxidoreductase" reversible="false">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC0202
         SUBSYSTEM: Pentose Phosphate Pathway
         EC Number: 1.1.5.2
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   distOfReactants>
      <speciesReference species="M_D_GLC_c" stoichiometry="1"/>
      <speciesReference species="M_Q_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_GLC_LACN_c" stoichiometry="1"/>
      <speciesReference species="M_QH2_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R030" name="D-Fructose 6-phosphate:D-glyceraldehyde-3-phosphate glycolaldehyde transferase"</pre>
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1896
     SUBSYSTEM: Pentose Phosphate Pathway
     EC Number: 2.2.1.1
     Confidence Level: 1
     AUTHORS: Carbohydrate metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_F6P_c" stoichiometry="1"/>
    <speciesReference species="M_GAP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_E4P_c" stoichiometry="1"/>
    <speciesReference species="M_XYL5P_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
```

```
distOfParameters>
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R031" name="sedoheptulose-7-phosphate:D-glyceraldehyde-3-phosphate glyceronetransferase"</pre>
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0701
     SUBSYSTEM: Pentose Phosphate Pathway
     EC Number: 2.2.1.2
     Confidence Level: 1
     AUTHORS: Carbohydrate metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_GAP_c" stoichiometry="1"/>
    <speciesReference species="M_SEDHEP7P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_F6P_c" stoichiometry="1"/>
    <speciesReference species="M_E4P_c" stoichiometry="1"/>
   </listOfProducts>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R032" name="Sedoheptulose-7-phosphate:D-glyceraldehyde-3-phosphate glycolaldehyde transferase"</pre>
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1896
     SUBSYSTEM: Pentose Phosphate Pathway
     EC Number: 2.2.1.1
     Confidence Level: 1
     AUTHORS: Carbohydrate metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M GAP c" stoichiometry="1"/>
    <speciesReference species="M_SEDHEP7P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
```

<kineticLaw>

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<speciesReference species="M_XYL5P_c" stoichiometry="1"/>
 <speciesReference species="M R5P c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R033" name="D-Ribulose-5-phosphate 3-epimerase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC1898
  SUBSYSTEM: Pentose Phosphate Pathway
  EC Number: 5.1.3.1
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M RBL5P c" stoichiometry="1"/>
 </listOfReactants>
```

```
distOfProducts>
 <speciesReference species="M_XYL5P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R034" name="D-ribose-5-phosphate aldose-ketose-isomerase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC0932
  SUBSYSTEM: Pentose Phosphate Pathway
  EC Number: 5.3.1.6
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_R5P_c" stoichiometry="1"/>
 </listOfReactants>
```

```
distOfProducts>
 <speciesReference species="M RBL5P c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R035" name="ATP:D-ribose-5-phosphate diphosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: (TTC1184 or TTC1274)
  SUBSYSTEM: Pentose Phosphate Pathway
  EC Number: 2.7.6.1
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_R5P_c" stoichiometry="1"/>
```

```
</listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M_PRPP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R036" name="D-Ribose 1,5-phosphomutase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1630 or TTC1659)
  SUBSYSTEM: Pentose Phosphate Pathway
  EC Number: 5.4.2.2 or 5.4.2.7
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
```

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listOfReactants>
     <speciesReference species="M_R1P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_R5P_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R037" name="ATP:D-ribose 5-phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0063
         SUBSYSTEM: Pentose Phosphate Pathway
         EC Number: 2.7.1.15
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
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<speciesReference species="M ATP c" stoichiometry="1"/>
             <speciesReference species="M_D_RIB_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_ADP_c" stoichiometry="1"/>
             <speciesReference species="M_H_c" stoichiometry="1"/>
             <speciesReference species="M_R5P_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             </listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R038" name="2-deoxy-D-ribose-5-phosphate acetaldehyde-lyase (D-glyceraldehyde-3-phosphate-forming)"
reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE ASSOCIATION: TTC0823
                SUBSYSTEM: Pentose Phosphate Pathway
                EC Number: 4.1.2.4
                Confidence Level: 1
```

listOfReactants>

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AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_dR5P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_GAP_c" stoichiometry="1"/>
 <speciesReference species="M_AALD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R039" name="2-deoxy-D-ribose 1-phosphate 1,5-phosphomutase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1659
   SUBSYSTEM: Pentose Phosphate Pathway
   EC Number: 5.4.2.7
```

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Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_dR1P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_dR5P_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R040" name="glyceraldehyde ferredoxin oxidoreductase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC1834
         SUBSYSTEM: Pentose Phosphate Pathway
         EC Number: 1.2.7.5
```

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Confidence Level: 1
                AUTHORS: Carbohydrate metabolism
                </body>
           </notes>
           listOfReactants>
             <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M_NAD_c" stoichiometry="1"/>
             <speciesReference species="M_GLYALD_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_H_c" stoichiometry="2"/>
             <speciesReference species="M_NADH_c" stoichiometry="1"/>
             <speciesReference species="M_D_GLCT_c" stoichiometry="1"/>
           /listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R R041" name="2-dehydro-3-deoxy-D-gluconate-6-phosphate D-glyceraldehyde-3-phosphate-lyase"</pre>
reversible="false">
```

```
<notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TT_P0030
         SUBSYSTEM: Pentose Phosphate Pathway
         EC Number: 4.1.2.14
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_DHY_DOP_GLUCN_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_GAP_c" stoichiometry="1"/>
     <speciesReference species="M_PYR_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
```

```
<reaction id="R_R042" name="2-Dehydro-3-deoxy-D-gluconate:NAD+ 5-oxidoreductase" reversible="true">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TT_P0037
        SUBSYSTEM: Pentose Phosphate Pathway
        EC Number: 1.1.1.125
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
  </notes>
  distOfReactants>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_2K3DO_GLCN_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M DHY DOHEXNA c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R043" name="D-fructose 1-phosphate D-glyceraldehyde-3-phosphate-lyase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1414
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 4.1.2.13
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_F1P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M DHAP c" stoichiometry="1"/>
 <speciesReference species="M_GLYALD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R044" name="L-Fuculose-1-phosphate lactaldehyde-lyase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1459
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 4.1.2.17
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_FUCL1P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_DHAP_c" stoichiometry="1"/>
 <speciesReference species="M_LALD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R045" name="L-lactaldehyde:NAD+ oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0513
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 1.2.1.22
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M NAD c" stoichiometry="1"/>
 <speciesReference species="M_LALD_c" stoichiometry="1"/>
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 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_LAC_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
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distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R046" name="GDP-mannose:3-phosphoglycerate 3-a-D-mannosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0588
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 2.4.1.217
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_3PG_c" stoichiometry="1"/>
 <speciesReference species="M_GDP_MAN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_GDP_c" stoichiometry="1"/>
 <speciesReference species="M_MANNPGLYCT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R047" name="alpha-D-mannosyl-3-phosphoglycerate phosphohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0589
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 3.1.3.70
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_MANNPGLYCT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_AMANN_GLYCT_c" stoichiometry="1"/>
```

```
</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R048" name="D-mannose 6-phosphate 1,6-phosphomutase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1630 or TTC0291 or TTC1063)
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 5.4.2.8
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_M6P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_MAN1P_c" stoichiometry="1"/>
```

```
</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R049" name="GDP:D-mannose-1-phosphate guanylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1388
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 2.7.7.22
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GDP_c" stoichiometry="1"/>
 <speciesReference species="M MAN1P c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_GDP_MAN_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R050" name="ATP:D-fructose 6-phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0630
        SUBSYSTEM: Alternate Carbon Metabolism
        EC Number: 2.7.1.4
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
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<speciesReference species="M_D_FRU_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_F6P_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R051" name="D-mannose-6-phosphate aldose-ketose-isomerase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0980
        SUBSYSTEM: Alternate Carbon Metabolism
        EC Number: 5.3.1.8
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
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</notes>
 listOfReactants>
 <speciesReference species="M_M6P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_F6P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R052" name="ATP:D-galactose 1-phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0226
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 2.7.1.6
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
```

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</notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GAL1P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R053" name="UDP-glucose:alpha-D-galactose-1-phosphate uridylyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0071
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 2.7.7.12
   Confidence Level: 1
```

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AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GAL1P_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_GLU_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_G1P_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_GAL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R054" name="UDP-glucose 4-epimerase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0222
   SUBSYSTEM: Alternate Carbon Metabolism
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EC Number: 5.1.3.2
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_UDP_GLU_c" stoichiometry="1"/>
 </listOfReactants>
 ducts>
 <speciesReference species="M_UDP_GAL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R055" name="Galactan galactohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: (TT P0220 or TT P0222)
  SUBSYSTEM: Alternate Carbon Metabolism
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EC Number: 3.2.1.23
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_GLCTN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M D GAL c" stoichiometry="2"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R056" name="Lactose galactohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TT_P0220 or TT_P0222)
```

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SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 3.2.1.23
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_LACTS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GLC_c" stoichiometry="1"/>
 <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R057" name="alpha-D-glucose 1,6-phosphomutase" reversible="true">
 <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
         GENE ASSOCIATION: (TTC1630 or TTC0291 or TTC1063)
         SUBSYSTEM: Alternate Carbon Metabolism
         EC Number: 5.4.2.2
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   <speciesReference species="M_G1P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_G6P_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
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         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R058" name="Epimelibiose galactohydrolase" reversible="true">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
        GENE ASSOCIATION: TT P0072
        SUBSYSTEM: Alternate Carbon Metabolism
        EC Number: 3.2.1.22
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M EPMLBIOS c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_D_MAN_c" stoichiometry="1"/>
     <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
```

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<reaction id="R_R059" name="3-O-alpha-D-Galactosyl-1D-myo-inositol galactohydrolase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TT_P0072
        SUBSYSTEM: Alternate Carbon Metabolism
        EC Number: 3.2.1.22
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_AGAL_INS_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
     <speciesReference species="M_M_INS_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     </listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R060" name="Melibiitol galactohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0072
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 3.2.1.22
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_MLBTL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M D GAL c" stoichiometry="1"/>
 <speciesReference species="M_SORB_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R061" name="Galactosylglycerol galactohydrolase" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TT_P0072
         SUBSYSTEM: Alternate Carbon Metabolism
         EC Number: 3.2.1.22
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_H2O_c" stoichiometry="1"/>
      <speciesReference species="M_GALCS_GLYC_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
      <speciesReference species="M_GLYCRL_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R062" name="alkaline alpha-galactosidase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0072
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 3.2.1.22
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_STCYS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
 <speciesReference species="M_RAFF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
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```
<parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R063" name="Manninotriose galactohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TT P0072
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 3.2.1.22
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_MANNTRIS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
 <speciesReference species="M_MLBIOS_c" stoichiometry="1"/>
 </listOfProducts>
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 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

<listOfParameters>

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<ci> FLUX_VALUE </ci>
 distOfParameters>
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   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R064" name="Raffinose galactohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TT P0072
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 3.2.1.22
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_RAFF_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
 <speciesReference species="M SUC c" stoichiometry="1"/>
 </listOfProducts>
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<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R065" name="melibiose galactohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0072
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 3.2.1.22
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_MLBIOS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GLC_c" stoichiometry="1"/>
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<speciesReference species="M_D_GAL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R066" name="sucrose glucohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0107 or TTC1283 or TT_P0221)
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 3.2.1.20
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_SUC_c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
     <speciesReference species="M_D_GLC_c" stoichiometry="1"/>
     <speciesReference species="M_D_FRU_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R067" name="palatinose glucohydrolase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0107 or TTC1283 or TT_P0221)
        SUBSYSTEM: Alternate Carbon Metabolism
        EC Number: 3.2.1.20
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
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<speciesReference species="M_PALT_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_D_GLC_c" stoichiometry="1"/>
     <speciesReference species="M_D_FRU_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
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        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R068" name="octaprenyl-diphosphate synthase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1291
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.5.1.90
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
```

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listOfReactants>
 <speciesReference species="M ct FARPPi c" stoichiometry="1"/>
 <speciesReference species="M_IPEN_PPi_c" stoichiometry="5"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="5"/>
 <speciesReference species="M_t_PPREPPi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R069" name="chorismate lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 4.1.3.40
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
```

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</body>
 </notes>
 distOfReactants>
 <speciesReference species="M_CORM_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_HY_BNZA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R070" name="Polyisopentenylpyrolinate:4-hydroxybenzoate nonaprenyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0240 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.5.1.39
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_t_PPREPPi_c" stoichiometry="1"/>
     <speciesReference species="M_HY_BNZA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M_HY_PPREBNZA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R071" name="4-hydroxy-3-polyprenylbenzoate carboxy-lyase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1553
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 4.1.1.-
```

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Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_PPRENPhOL_c" stoichiometry="1"/>
 </listOfReactants>
 ducts>
 <speciesReference species="M_HY_PPREBNZA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R072" name="polyprenylphenol hydroxylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
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EC Number: 1.14.13.-
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_PPRENPhOL_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_PBDIOL_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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```
<reaction id="R_R073" name="2-polyprenyl-6-hydroxyphenol methylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.1.1.222
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PBDIOL_c" stoichiometry="1"/>
 <speciesReference species="M_SAM_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_METPPHOL_c" stoichiometry="1"/>
 <speciesReference species="M SAHC c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R074" name="2-methoxy-6-all-trans-polyprenylphenol hydroxylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.14.13.-
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M METPPHOL c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_PPRE_MOX_BNZQ_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R075" name="2-Polyprenyl-6-methoxy-1,4-benzoquinone hydroxylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.14.13.-
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_PPRE_MOX_BNZQ_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M DEMQH2 c" stoichiometry="1"/>
 </listOfProducts>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R076" name="3-Demethylubiquinol methylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 2.1.1.64
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SAM_c" stoichiometry="1"/>
 <speciesReference species="M_DEMQH2_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
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<kineticLaw>

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<speciesReference species="M_QH2_c" stoichiometry="1"/>
 <speciesReference species="M SAHC c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
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 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R077" name="ubiquinone/menaquinone biosynthesis methyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1503
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.1.1.201
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
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 distOfReactants>
 <speciesReference species="M SAM c" stoichiometry="1"/>
 <speciesReference species="M_PPRE_MOX_BNZQ_c" stoichiometry="1"/>
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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_SAHC_c" stoichiometry="1"/>
 <speciesReference species="M_PPRE_MMOX_BNZQ_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R078" name="2-Polyprenyl-3-methyl-6-methoxy-1,4-benzoquinone hydroxylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.14.13.-
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
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<speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M O2 c" stoichiometry="1"/>
 <speciesReference species="M_PPRE_MMOX_BNZQ_c" stoichiometry="1"/>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_DMMQ_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R079" name="S-adenosyl-L-methione:demethylmenaquinone methyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1503
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 2.1.1.163
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
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</body>
   </notes>
   listOfReactants>
    <speciesReference species="M_SAM_c" stoichiometry="1"/>
    <speciesReference species="M_DMMQ_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_SAHC_c" stoichiometry="1"/>
    <speciesReference species="M_MQ_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
    listOfParameters>
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R080" name="(1R,6R)-6-hydroxy-2-succinylcyclohexa-2,4-diene-1-carboxylate hydrolyase (2-
succinylbenzoate-forming)" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0519
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
```

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EC Number: 4.2.1.113
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_HY_SUCC_CYCHEXDE_CARBA_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M SUCC BNZA c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R081" name="Acetyl-CoA:carbon-dioxide ligase (ADP-forming)" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0758 and TTC1408 and TTC1409)
```

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SUBSYSTEM: Cell Envelope Biosynthesis
                 EC Number: 6.4.1.2
                 Confidence Level: 1
                 AUTHORS: Lipid metabolism
                 </body>
           </notes>
           listOfReactants>
              <speciesReference species="M_ACoA_c" stoichiometry="1"/>
              <speciesReference species="M_CBTN_CCP_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M_MALCoA_c" stoichiometry="1"/>
              <speciesReference species="M_HCARB_c" stoichiometry="1"/>
           /listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
              definition of the control of
                 <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R R082" name="glutaryl-CoA:electron-transfer flavoprotein 2,3-oxidoreductase (decarboxylating)"
reversible="false">
```

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<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: TTC0435
 SUBSYSTEM: Membrane Lipid Metabolism
 EC Number: 1.3.8.6
 Confidence Level: 1
 AUTHORS: Lipid metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_H_c" stoichiometry="1"/>
<speciesReference species="M_FAD_c" stoichiometry="1"/>
<speciesReference species="M_GLUTRCoA_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_CO2_c" stoichiometry="1"/>
<speciesReference species="M_FADH2_c" stoichiometry="1"/>
<speciesReference species="M CROCoA c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
<listOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R083" name="NADH:ubiquinone oxidoreductase" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     <GENE ASSOCIATION: (TTC1907 and TTC1908 and TTC1909 and TTC1910 and TTC1911 and TTC1912 and TTC1913 and</p>
TTC1914 and TTC1915 and TTC1916 and TTC1917 and TTC1918 and TTC1919 and TTC1920 and TT_P0054)
     SUBSYSTEM: Oxidative Phosphorylation
     EC Number: 1.6.5.3
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H_c" stoichiometry="4"/>
    <speciesReference species="M_NADH_c" stoichiometry="1"/>
    <speciesReference species="M_Q_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_NAD_c" stoichiometry="1"/>
    <speciesReference species="M_QH2_c" stoichiometry="1"/>
    <speciesReference species="M_H_e" stoichiometry="3"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
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<parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R084" name="Ubiquinol:ferricytochrome-c oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Oxidative Phosphorylation
   EC Number: 1.10.2.2
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_QH2_c" stoichiometry="1"/>
 <speciesReference species="M_CYT_C3_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Q_c" stoichiometry="1"/>
 <speciesReference species="M_CYT_C2_c" stoichiometry="2"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<listOfParameters>

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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R085" name="diphosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1600
   SUBSYSTEM: Anaplerotic Reactions
   EC Number: 3.6.1.1
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="2"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 </listOfProducts>
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<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R086" name="ATP phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TT_P0081 or TT_P0211 or TTC1823 or TTC1844 or TTC1290)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.6.3.14
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
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<speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M H c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R087" name="ADP-ribose ribophosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: (TTC0160 or TTC0511)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.6.1.13
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_RIB_c" stoichiometry="1"/>
```

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</listOfReactants>
           distOfProducts>
             <speciesReference species="M_H_c" stoichiometry="2"/>
             <speciesReference species="M_AMP_c" stoichiometry="1"/>
             <speciesReference species="M_R5P_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                 <ci> FLUX_VALUE </ci>
             definition of the control of
                 <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R R088" name="5-phosphoribosylamine:diphosphate phospho-alpha-D-ribosyltransferase (glutamate-
amidating)" reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE_ASSOCIATION: TTC1156
                 SUBSYSTEM: Nucleotide Salvage Pathway
                 EC Number: 2.4.2.14
                 Confidence Level: 1
                 AUTHORS: Nucleotides metabolism
                 </body>
```

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</notes>
  listOfReactants>
     <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_PRPP_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
     <speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M_PRIBSAMN_c" stoichiometry="1"/>
  /listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R089" name="5-Phospho-D-ribosylamine:glycine ligase (ADP-forming)" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0460
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 6.3.4.13
```

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Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
</notes>
listOfReactants>
 <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_PRIBSAMN_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GAR_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 IistOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
</kineticLaw>
</reaction>
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```
< reaction\ id="R_R090"\ name="5\&apos;-Phosphoribosylformylglycinamide: L-glutamine\ amido-ligase\ (ADP-forming)"\ reversible="false">
```

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<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE ASSOCIATION: (TTC1152 or TTC1153 or TTC1155 or TTC1383)
 SUBSYSTEM: Nucleotide Salvage Pathway
 EC Number: 6.3.5.3
 Confidence Level: 1
 AUTHORS: Nucleotides metabolism
 </body>
</notes>
distOfReactants>
<speciesReference species="M_L_GLN_c" stoichiometry="1"/>
<speciesReference species="M_ATP_c" stoichiometry="1"/>
<speciesReference species="M_H2O_c" stoichiometry="1"/>
<speciesReference species="M_FGAR_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_L_GLU_c" stoichiometry="1"/>
<speciesReference species="M_ADP_c" stoichiometry="1"/>
<speciesReference species="M_Pi_c" stoichiometry="1"/>
<speciesReference species="M_H_c" stoichiometry="1"/>
<speciesReference species="M_FGAM_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
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<parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R091" name="2-(Formamido)-N1-(5-phosphoribosyl)acetamidine cyclo-ligase (ADP-forming)"
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1619
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 6.3.3.1
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_FGAM_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M ADP c" stoichiometry="1"/>
    <speciesReference species="M_Pi_c" stoichiometry="1"/>
    <speciesReference species="M_H_c" stoichiometry="2"/>
    <speciesReference species="M_AIR_c" stoichiometry="1"/>
```

<listOfParameters>

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</listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
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              definition of the control of
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                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R R092" name="5-amino-1-(5-phospho-D-ribosyl)imidazole:carbon-dioxide ligase (ADP-forming)"
reversible="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE_ASSOCIATION: TTC0137
                 SUBSYSTEM: Nucleotide Salvage Pathway
                 EC Number: 6.3.4.18
                 Confidence Level: 1
                 AUTHORS: Nucleotides metabolism
                 </body>
           </notes>
           listOfReactants>
              <speciesReference species="M_ATP_c" stoichiometry="1"/>
              <speciesReference species="M_AIR_c" stoichiometry="1"/>
              <speciesReference species="M_HCO3_c" stoichiometry="1"/>
```

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</listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_5CAIZ_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R093" name="5-carboxyamino-1-(5-phospho-D-ribosyl)imidazole carboxymutase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0138
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 5.4.99.18
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
```

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</notes>
           listOfReactants>
              <speciesReference species="M_5CAIZ_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M_CAIR_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                 <ci> FLUX_VALUE </ci>
              definition of the control of
                 <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R094" name="1-(5-Phosphoribosyl)-5-amino-4-carboxyimidazole:L-aspartate ligase (ADP-forming)"</pre>
reversible="true">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE_ASSOCIATION: TTC1151
                 SUBSYSTEM: Nucleotide Salvage Pathway
                 EC Number: 6.3.2.6
                 Confidence Level: 1
                 AUTHORS: Nucleotides metabolism
```

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</body>
    </notes>
    listOfReactants>
    <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_CAIR_c" stoichiometry="1"/>
    </listOfReactants>
    listOfProducts>
    <speciesReference species="M_ADP_c" stoichiometry="1"/>
    <speciesReference species="M_Pi_c" stoichiometry="1"/>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M SAICAR c" stoichiometry="1"/>
    </or>
    <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
      <ci> FLUX_VALUE </ci>
    <listOfParameters>
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      <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
    </kineticLaw>
  </reaction>
  <reaction id="R_R095" name="1-(5&apos;-Phosphoribosyl)-5-amino-4-(N-succinocarboxamide)-imidazole AMP-lyase"
reversible="true">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC1149
                 SUBSYSTEM: Nucleotide Salvage Pathway
                 EC Number: 4.3.2.2
                 Confidence Level: 1
                 AUTHORS: Nucleotides metabolism
                 </body>
           </notes>
           listOfReactants>
              <speciesReference species="M_SAICAR_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M_FUM_c" stoichiometry="1"/>
              <speciesReference species="M_AICAR_c" stoichiometry="1"/>
           /listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
              definition of the control of
                 <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R R096" name="1-(5&apos;-Phosphoribosyl)-5-amino-4-imidazolecarboxamide:pyrophosphate
phosphoribosyltransferase" reversible="true">
```

```
<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC1249 or TTC1250)
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 2.4.2.7
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_AICAR_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_PRPP_c" stoichiometry="1"/>
  <speciesReference species="M_5A_4IMDZCARBA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

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</reaction>
        <reaction id="R R097" name="10-Formyltetrahydrofolate:5&apos;-phosphoribosyl-5-amino-4-imidazolecarboxamide
formyltransferase" reversible="true">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE_ASSOCIATION: TTC0561
                 SUBSYSTEM: Nucleotide Salvage Pathway
                 EC Number: 2.1.2.3
                 Confidence Level: 1
                 AUTHORS: Nucleotides metabolism
                 </body>
           </notes>
           listOfReactants>
              <speciesReference species="M_AICAR_c" stoichiometry="1"/>
              <speciesReference species="M_10F_THF_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M THF c" stoichiometry="1"/>
              <speciesReference species="M_FAICAR_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
              definition of the control of
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                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R098" name="IMP 1,2-hydrolase (decyclizing)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0561
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.5.4.10
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_IMP_c" stoichiometry="1"/>
 </listOfReactants>
 ducts>
 <speciesReference species="M_FAICAR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R099" name="P1,P4-bis(5&apos;-adenosyl)-tetraphosphate adenylohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1519 or TTC1859)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.17
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M BADNS PPP c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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```
<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R100" name="ATP:sulfate adenylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0307
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.7.4
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_SO4_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_APS_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R101" name="ATP:dIDP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1798
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.4.6
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dIDP_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_dITP_c" stoichiometry="1"/>
 </listOfProducts>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R102" name="2&apos;-Deoxyinosine-5&apos;-triphosphate pyrophosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1290 or TTC1583)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.19
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_dITP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
```

<kineticLaw>

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<speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M dIMP c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R103" name="guanosine 3&apos;-diphosphate 5&apos;-triphosphate 5&apos;-phosphohydrolase"</p>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0636
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 3.6.1.40
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
```

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<speciesReference species="M_GUNS_3PPi_5TPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GUNSBP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R104" name="P1,P4-bis(5&apos;-guanosyl)-tetraphosphate guanylylhydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1519 or TTC1859)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.17
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
```

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</notes>
 distOfReactants>
 <speciesReference species="M_GTP_c" stoichiometry="1"/>
 <speciesReference species="M_GMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_BGUNS_PPP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R105" name="dGTP triphosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0044
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.1.5.1
   Confidence Level: 1
```

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AUTHORS: Nucleotides metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_dGTP_c" stoichiometry="1"/>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_dGUNS_c" stoichiometry="1"/>
    <speciesReference species="M_TPi_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R106" name="guanosine-3&apos;,5&apos;-bis(diphosphate) 3&apos;-diphosphohydrolase"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1355
```

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SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.1.7.2
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_GUNSBP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_GDP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R107" name="ATP:GDP phosphotransferase" reversible="false">
 <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC1798
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.6
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_GDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_GTP_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

```
<reaction id="R_R108" name="ATP:dGDP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1798
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.6
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dGDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_dGTP_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
```

```
</kineticLaw>
</reaction>
<reaction id="R_R109" name="dGTP:pyruvate 2-O-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1611
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.1.40
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_PEP_c" stoichiometry="1"/>
 <speciesReference species="M_dGDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_dGTP_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R110" name="2&apos;-Deoxyguanosine 5&apos;-triphosphate diphosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1290 or TTC1583)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.6.1.19
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_dGTP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 ducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_dGMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R111" name="2&apos;-Deoxyguanosine 5&apos;-monophosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.1.3.5
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_dGMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_dGUNS_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R112" name="2&apos;-Deoxyguanosine 5&apos;-diphosphate:oxidized-thioredoxin 2&apos;-</p>
oxidoreductase" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC1930 and TT_P0161 and TT_P0162)
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 1.17.4.1
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_GDP_c" stoichiometry="1"/>
    <speciesReference species="M_R_TRED_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_dGDP_c" stoichiometry="1"/>
    <speciesReference species="M_O_TRED_c" stoichiometry="1"/>
```

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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R113" name="ATP:dGMP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1197
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.8
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dGMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M dGDP c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R114" name="Deoxyguanosine:orthophosphate ribosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: ((TTC0194 or TTC1070) or TTC1412)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.4.2.1 or 2.4.2.4
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_dGUNS_c" stoichiometry="1"/>
```

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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_dR1P_c" stoichiometry="1"/>
 <speciesReference species="M_GUN_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R115" name="GTP diphosphohydrolase (diphosphate-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1290 or TTC1583)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.6.1.19
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
```

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<speciesReference species="M_GTP_c" stoichiometry="1"/>
     <speciesReference species="M H2O c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_GMP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R116" name="ATP:GMP phosphotransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1197
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 2.7.4.8
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
```

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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_GMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_GDP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R117" name="Guanosine 5&apos;-monophosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.1.3.5
   Confidence Level: 1
```

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AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_GMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_GUNS_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R118" name="guanosine:phosphate alpha-D-ribosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC0194 or TTC1070)
   SUBSYSTEM: Nucleotide Salvage Pathway
```

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EC Number: 2.4.2.1
         Confidence Level: 1
         AUTHORS: Nucleotides metabolism
         </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_GUNS_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_R1P_c" stoichiometry="1"/>
     <speciesReference species="M_GUN_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R119" name="GMP:diphosphate 5-phospho-alpha-D-ribosyltransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: ((TTC1249 or TTC1250) or TTC1766)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.4.2.7 or 2.4.2.8
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PRPP_c" stoichiometry="1"/>
 <speciesReference species="M_GUN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_GMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R120" name="Xanthosine-5&apos;-phosphate:ammonia ligase (AMP-forming)" reversible="false">
```

```
<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: TTC1187
 SUBSYSTEM: Nucleotide Salvage Pathway
 EC Number: 6.3.5.2
 Confidence Level: 1
 AUTHORS: Nucleotides metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_ATP_c" stoichiometry="1"/>
<speciesReference species="M_XMP_c" stoichiometry="1"/>
<speciesReference species="M_NH4_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_PPi_c" stoichiometry="1"/>
<speciesReference species="M_H_c" stoichiometry="2"/>
<speciesReference species="M AMP c" stoichiometry="1"/>
<speciesReference species="M_GMP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
listOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R121" name="P1,P4-Bis(5&apos;-nucleosyl)-tetraphosphate nucleotidohydrolase" reversible="false">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: (TTC1519 or TTC1859)
         SUBSYSTEM: Nucleotide Salvage Pathway
         EC Number: 3.6.1.17
         Confidence Level: 1
         AUTHORS: Nucleotides metabolism
         </body>
   </notes>
   distOfReactants>
      <speciesReference species="M_H2O_c" stoichiometry="1"/>
      <speciesReference species="M_XppppX_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_XMP_c" stoichiometry="1"/>
      <speciesReference species="M_XTP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R122" name="Inosine 5&apos;-triphosphate pyrophosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1290 or TTC1583)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.19
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_ITP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_IMP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R123" name="ATP:IDP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1798
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.4.6
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_IDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_ITP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R124" name="XTP pyrophosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1290 or TTC1583)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.19
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_XTP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
```

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<speciesReference species="M_XMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R125" name="Xanthosine 5&apos;-phosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.1.3.5
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M XMP c" stoichiometry="1"/>
 </listOfReactants>
```

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listOfProducts>
     <speciesReference species="M Pi c" stoichiometry="1"/>
     <speciesReference species="M_XNTHS_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R126" name="XMP:pyrophosphate phosphoribosyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1766
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 2.4.2.22 or 2.4.2.8
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_PRPP_c" stoichiometry="1"/>
```

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<speciesReference species="M_XTHN_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M_XMP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R127" name="Xanthosine:orthophosphate ribosyltransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0194 or TTC1070)
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 2.4.2.1
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
   </notes>
```

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listOfReactants>
 <speciesReference species="M Pi c" stoichiometry="1"/>
 <speciesReference species="M_XNTHS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_R1P_c" stoichiometry="1"/>
 <speciesReference species="M_XTHN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R128" name="IMP:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0064 or TTC1634)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 1.1.1.205
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
```

```
</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_IMP_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_XMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R129" name="IMP:diphosphate phospho-D-ribosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1766
   SUBSYSTEM: Nucleotide Salvage Pathway
```

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EC Number: 2.4.2.8
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PRPP_c" stoichiometry="1"/>
 <speciesReference species="M_HXTHN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M PPi c" stoichiometry="1"/>
 <speciesReference species="M_IMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R130" name="Inosine 5&apos;-monophosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.1.3.5
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_IMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_INSN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R131" name="inosine:phosphate alpha-D-ribosyltransferase" reversible="true">
```

```
<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC0194 or TTC1070)
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 2.4.2.1
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_Pi_c" stoichiometry="1"/>
  <speciesReference species="M_INSN_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_R1P_c" stoichiometry="1"/>
  <speciesReference species="M_HXTHN_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R132" name="IMP:L-aspartate ligase (GDP-forming)" reversible="false">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC1764
         SUBSYSTEM: Nucleotide Salvage Pathway
         EC Number: 6.3.4.4
         Confidence Level: 1
         AUTHORS: Nucleotides metabolism
        </body>
   </notes>
   <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
      <speciesReference species="M_GTP_c" stoichiometry="1"/>
      <speciesReference species="M_IMP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M Pi c" stoichiometry="1"/>
      <speciesReference species="M_H_c" stoichiometry="2"/>
      <speciesReference species="M_GDP_c" stoichiometry="1"/>
      <speciesReference species="M_ADN_SUCC_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R133" name="N6-(1,2-dicarboxyethyl)AMP AMP-lyase (fumarate-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1149
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 4.3.2.2
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M ADN SUCC c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M_FUM_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R134" name="Adenosine 5&apos;-monophosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.1.3.5
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_ADSN_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R135" name="Adenosine:phosphate alpha-D-ribosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0194 or TTC1070)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.4.2.1
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_ADSN_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_R1P_c" stoichiometry="1"/>
 <speciesReference species="M_ADN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R136" name="Deoxyinosine:orthophosphate ribosyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: ((TTC0194 or TTC1070) or TTC1412)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.4.2.1 or 2.4.2.4
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_zCARO_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M dR1P c" stoichiometry="1"/>
 <speciesReference species="M_HXTHN_c" stoichiometry="1"/>
```

```
</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R137" name="Deoxyadenosine:orthophosphate ribosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0194 or TTC1070)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.4.2.1
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_dADS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

```
<speciesReference species="M_dR1P_c" stoichiometry="1"/>
 <speciesReference species="M ADN c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R138" name="ATP:ADP phosphatransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC1798
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.6
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfProducts>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
```

```
</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R139" name="ATP:AMP phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1307
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.3
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_ADP_c" stoichiometry="2"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R140" name="2&apos;-Deoxyadenosine 5&apos;-diphosphate:oxidized-thioredoxin 2&apos;-</p>
oxidoreductase" reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: (TTC1930 and TT P0161 and TT P0162)
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 1.17.4.1
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_ADP_c" stoichiometry="1"/>
    <speciesReference species="M_R_TRED_c" stoichiometry="1"/>
```

```
</listOfReactants>
   distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_O_TRED_c" stoichiometry="1"/>
     <speciesReference species="M_dADP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R141" name="ATP:dADP phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1798
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 2.7.4.6
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
   </notes>
```

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listOfReactants>
     <speciesReference species="M ATP c" stoichiometry="1"/>
     <speciesReference species="M_dADP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_dATP_c" stoichiometry="1"/>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R142" name="ATP:dAMP phosphotransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1307
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 2.7.4.3
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
```

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</body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dAMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_dADP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R143" name="2&apos;-Deoxyadenosine 5&apos;-monophosphate phosphohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.1.3.5
   Confidence Level: 1
```

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AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_dAMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_dADS_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R144" name="carbamoyl-phosphate:L-aspartate carbamoyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0427
   SUBSYSTEM: Nucleotide Salvage Pathway
```

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EC Number: 2.1.3.2
                 Confidence Level: 1
                 AUTHORS: Nucleotides metabolism
                 </body>
           </notes>
           distOfReactants>
              <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
              <speciesReference species="M_CARB_Pi_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M Pi c" stoichiometry="1"/>
              <speciesReference species="M_H_c" stoichiometry="1"/>
              <speciesReference species="M_CARB_ASP_c" stoichiometry="1"/>
           /listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
              definition of the control of
                 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R R145" name="hydrogen-carbonate:L-glutamine amido-ligase (ADP-forming, carbamate-phosphorylating)"
reversible="false">
```

```
<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: (TTC0247 and TTC1706)
 SUBSYSTEM: Nucleotide Salvage Pathway
 EC Number: 6.3.5.5
 Confidence Level: 1
 AUTHORS: Nucleotides metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_L_GLN_c" stoichiometry="1"/>
<speciesReference species="M_ATP_c" stoichiometry="2"/>
<speciesReference species="M_H2O_c" stoichiometry="1"/>
<speciesReference species="M_HCO3_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
<speciesReference species="M_L_GLU_c" stoichiometry="1"/>
<speciesReference species="M_ADP_c" stoichiometry="2"/>
<speciesReference species="M_Pi_c" stoichiometry="1"/>
<speciesReference species="M_H_c" stoichiometry="2"/>
<speciesReference species="M_CARB_Pi_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
distOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R146" name="(S)-dihydroorotate amidohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0426
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.5.2.3
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_DHY_ORTA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CARB_ASP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
```

```
<listOfParameters>
   <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R147" name="CTP aminohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1864
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.5.4.13
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CTP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_UTP_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

```
<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R148" name="NADPH:oxidized-thioredoxin oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC0096 or TTC0853 or TTC1555)
   SUBSYSTEM: Oxidative Phosphorylation
   EC Number: 1.8.1.9
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_O_TRED_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M NADP c" stoichiometry="1"/>
 <speciesReference species="M_R_TRED_c" stoichiometry="1"/>
```

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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R149" name="UTP:ammonia ligase (ADP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1102
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 6.3.4.2
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
 <speciesReference species="M_UTP_c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
```

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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_CTP_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R150" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
```

```
</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
     <speciesReference species="M_UTP_c" stoichiometry="1"/>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
     <speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M H c" stoichiometry="2"/>
     <speciesReference species="M_AMP_c" stoichiometry="1"/>
     <speciesReference species="M_GMP_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R151" name="dCTP aminohydrolase" reversible="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC1864
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 3.5.4.13
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_dCTP_c" stoichiometry="1"/>
  <speciesReference species="M H2O c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_NH4_c" stoichiometry="1"/>
  <speciesReference species="M_dUTP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
</kineticLaw>
```

```
</reaction>
        <reaction id="R R152" name="Orotidine-5&apos;-phosphate:diphosphate phospho-alpha-D-ribosyl-transferase"</pre>
reversible="true">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE_ASSOCIATION: TTC1380
                 SUBSYSTEM: Nucleotide Salvage Pathway
                 EC Number: 2.4.2.10
                 Confidence Level: 1
                 AUTHORS: Nucleotides metabolism
                 </body>
           </notes>
           <speciesReference species="M_PPi_c" stoichiometry="1"/>
              <speciesReference species="M_ORTD5P_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M PRPP c" stoichiometry="1"/>
              <speciesReference species="M_ORTA_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
              definition of the control of
                 <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R153" name="P1,P4-bis(5&apos;-uridyl)-tetraphosphate uridylohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1519 or TTC1859)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.17
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_UppppU_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_UTP_c" stoichiometry="1"/>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R154" name="ATP:UDP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1798
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.6
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_UTP_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
```

```
<listOfParameters>
   <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R155" name="ATP:CDP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1798
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.4.6
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_CDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CTP_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

```
<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R156" name="ATP:dCDP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1798
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.4.6
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dCDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_dCTP_c" stoichiometry="1"/>
 <speciesReference species="M ADP c" stoichiometry="1"/>
 </listOfProducts>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R157" name="ATP:dUDP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1798
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.6
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dUDP_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
```

<kineticLaw>

```
<speciesReference species="M_dUTP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R158" name="ATP:dTDP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1798
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.6
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M dTDP c" stoichiometry="1"/>
 </listOfReactants>
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<speciesReference species="M_dTTP_c" stoichiometry="1"/>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R159" name="Uridine triphosphate pyrophosphohydrolase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC1290 or TTC1583)
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 3.6.1.19
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_UTP_c" stoichiometry="1"/>
```

distOfProducts>

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<speciesReference species="M_H2O_c" stoichiometry="2"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_Pi_c" stoichiometry="2"/>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_UMP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R160" name="dUTP nucleotidohydrolase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC1290 or TTC1583)
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 3.6.1.19
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
```

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</notes>
           listOfReactants>
             <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M_dUTP_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_PPi_c" stoichiometry="1"/>
             <speciesReference species="M_H_c" stoichiometry="1"/>
             <speciesReference species="M_dUMP_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R161" name="2&apos;-Deoxycytidine diphosphate:oxidized-thioredoxin 2&apos;-oxidoreductase"</p>
reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: (TTC1930 and TT_P0161 and TT_P0162)
                SUBSYSTEM: Nucleotide Salvage Pathway
                EC Number: 1.17.4.1
```

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Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_R_TRED_c" stoichiometry="1"/>
    <speciesReference species="M_CDP_c" stoichiometry="1"/>
   </listOfReactants>
   ducts>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M O TRED c" stoichiometry="1"/>
    <speciesReference species="M_dCDP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R162" name="2&apos;-Deoxyuridine 5&apos;-diphosphate:oxidized-thioredoxin 2&apos;-oxidoreductase"
reversible="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: (TTC1930 and TT P0161 and TT P0162)
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 1.17.4.1
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_R_TRED_c" stoichiometry="1"/>
  <speciesReference species="M UDP c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M_O_TRED_c" stoichiometry="1"/>
  <speciesReference species="M_dUDP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R163" name="orotidine-5&apos;-phosphate carboxy-lyase (UMP-forming)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1381
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 4.1.1.23
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_ORTD5P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M UMP c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R164" name="ATP:UMP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0089 or TTC0507)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.14 or 2.7.4.22
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R165" name="ATP:CMP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0089
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.14
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_CMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_CDP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R166" name="ATP:dCMP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0089
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.4.15
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dCMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_dCDP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R167" name="ATP:dUMP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1243
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.4.9
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dUMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_dUDP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R168" name="ATP:dTMP phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1243
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.4.9
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_dTMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_dTDP_c" stoichiometry="1"/>
```

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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R169" name="ATP:uridine 5&apos;-phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0210
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.1.48
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M H c" stoichiometry="1"/>
     <speciesReference species="M_UMP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R170" name="ATP:cytidine 5&apos;-phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0210
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 2.7.1.48
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
```

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<speciesReference species="M_CYTD_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_CMP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R171" name="GTP:cytidine 5&apos;-phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0210
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 2.7.1.48
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
```

```
</notes>
 listOfReactants>
 <speciesReference species="M_GTP_c" stoichiometry="1"/>
 <speciesReference species="M_CYTD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GDP_c" stoichiometry="1"/>
 <speciesReference species="M_CMP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R172" name="guanosine nucleotides de novo biosynthesis" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 
   Confidence Level: 1
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AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_GTP_c" stoichiometry="1"/>
 <speciesReference species="M_FMN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_dGTP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M FMNH2 c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R173" name="UTP:uridine 5&apos;-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0210
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SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.1.48
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_UTP_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R174" name="GTP:uridine 5&apos;-phosphotransferase" reversible="false">
 <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC0210
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 2.7.1.48
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
</notes>
distOfReactants>
  <speciesReference species="M_GTP_c" stoichiometry="1"/>
  <speciesReference species="M URD c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_GDP_c" stoichiometry="1"/>
  <speciesReference species="M_UMP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R175" name="ITP:uridine 5&apos;-phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0210
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 2.7.1.48
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_ITP_c" stoichiometry="1"/>
     <speciesReference species="M_URD_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_IDP_c" stoichiometry="1"/>
     <speciesReference species="M UMP c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R176" name="dGTP:uridine 5&apos;-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0210
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.1.48
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_dGTP_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_dGDP_c" stoichiometry="1"/>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R177" name="dTTP:uridine 5&apos;-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0210
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.1.48
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_dTTP_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 <speciesReference species="M_dTDP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

```
<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R178" name="dCTP:uridine 5&apos;-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0210
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.1.48
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_dCTP_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 <speciesReference species="M_dCDP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R179" name="dUTP:uridine 5&apos;-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0210
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.1.48
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_dUTP_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 <speciesReference species="M_dUDP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R180" name="Uridine 5&apos;-monophosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.1.3.5
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
```

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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R181" name="Thymidylate 5&apos;-phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.1.3.5
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_dTMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M THYMD c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R182" name="2&apos;-Deoxycytidine 5&apos;-monophosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: (TTC0964 or TTC1625 or TT P0028)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.1.3.5
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_dCMP_c" stoichiometry="1"/>
```

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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_dCYTD_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R183" name="UMP:diphosphate phospho-alpha-D-ribosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0428 or TTC0946)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.4.2.9
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M UMP c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PRPP_c" stoichiometry="1"/>
     <speciesReference species="M_URA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R184" name="Cytidine aminohydrolase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0383
        SUBSYSTEM: Nucleotide Salvage Pathway
        EC Number: 3.5.4.5
        Confidence Level: 1
        AUTHORS: Nucleotides metabolism
        </body>
```

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</notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CYTD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R185" name="Deoxycytidine aminohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0383
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.5.4.5
   Confidence Level: 1
```

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AUTHORS: Nucleotides metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_dCYTD_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_NH4_c" stoichiometry="1"/>
     <speciesReference species="M dURD c" stoichiometry="1"/>
   </or>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R186" name="5,10-methylenetetrahydrofolate,NADPH:dUMP C-methyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE ASSOCIATION: TTC0731
```

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SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.1.1.148
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_dUMP_c" stoichiometry="1"/>
 <speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_THF_c" stoichiometry="1"/>
 <speciesReference species="M_dTMP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

```
<reaction id="R_R187" name="deoxyuridine:orthophosphate 2-deoxy-D-ribosyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: ((TTC0194 or TTC1070) or TTC1412)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.4.2.1 or 2.4.2.4
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_dURD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_dR1P_c" stoichiometry="1"/>
 <speciesReference species="M_URA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R188" name="thymidine:phosphate deoxy-alpha-D-ribosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1412
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.4.2.4
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_THYMD_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M dR1P c" stoichiometry="1"/>
 <speciesReference species="M_THYM_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R189" name="dihydropyrimidine dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 1.3.1.2
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M THYM c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_DHTHYM_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R190" name="dihydropyrimidinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0426
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.5.2.2
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_DHTHYM_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UREIDO_BUTR_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R191" name="3-Ureidoisobutyrate amidohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1539
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.5.1.6
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_UREIDO_BUTR_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 <speciesReference species="M 3AIBUTNA c" stoichiometry="1"/>
 </listOfProducts>
```

```
<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R192" name="L-Alanine:NAD+ oxidoreductase (deaminating)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1082 or TTC1770)
   SUBSYSTEM: Alanine and Aspartate Metabolism
   EC Number: 1.4.1.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
 <speciesReference species="M_L_ALA_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R193" name="L-Alanine:glyoxylate aminotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1813
  SUBSYSTEM: Alanine and Aspartate Metabolism
  EC Number: 2.6.1.44
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_L_ALA_c" stoichiometry="1"/>
     <speciesReference species="M GLOXT c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
     <speciesReference species="M_PYR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R194" name="L-Citrulline:L-aspartate ligase (AMP-forming)" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1701
        SUBSYSTEM: Arginine and Proline Metabolism
        EC Number: 6.3.4.5
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
```

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</notes>
 listOfReactants>
  <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_CTRLN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_AMP_c" stoichiometry="1"/>
  <speciesReference species="M_L_ARG_SUCC_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
  <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R195" name="2-(Nomega-L-arginino)succinate arginine-lyase (fumarate-forming)" reversible="false">
 <notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1702
   SUBSYSTEM: Arginine and Proline Metabolism
```

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EC Number: 4.3.2.1
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_ARG_SUCC_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_L_ARG_c" stoichiometry="1"/>
 <speciesReference species="M_FUM_c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R196" name="L-aspartate:ammonia ligase (AMP-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0282
```

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SUBSYSTEM: Alanine and Aspartate Metabolism
     EC Number: 6.3.5.4
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_NH4_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_L_ASN_c" stoichiometry="1"/>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_AMP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

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</reaction>
<reaction id="R R197" name="L-asparginase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1938
  SUBSYSTEM: Alanine and Aspartate Metabolism
  EC Number: 3.5.1.1
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_ASN_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R198" name="L-Aspartate:2-oxoglutarate aminotransferase" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: (TTC1960 or TTC1641)
         SUBSYSTEM: Alanine and Aspartate Metabolism
         EC Number: 2.6.1.1
         Confidence Level: 1
         AUTHORS: Amino acid metabolism
         </body>
   </notes>
   distOfReactants>
      <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
      <speciesReference species="M_AKG_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
      <speciesReference species="M_OAC_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R199" name="Succinate-semialdehyde:NADP+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0634
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 1.2.1.16
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_SUCC_SA_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_SUCC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R200" name="4-aminobutanoate:2-oxoglutarate aminotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0510
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 2.6.1.19
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_4ABUT_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M SUCC SA c" stoichiometry="1"/>
 </listOfProducts>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R201" name="L-glutamate:NAD+ oxidoreductase (deaminating)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1211 or TTC1212)
  SUBSYSTEM: Glutamate Metabolism
  EC Number: 1.4.1.3
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

<kineticLaw>

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<speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M NADH c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R202" name="L-Glutamate:NADP+ oxidoreductase (deaminating)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1104 or (TTC1211 or TTC1212))
  SUBSYSTEM: Glutamate Metabolism
  EC Number: (1.4.1.13 or 1.4.1.14)
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_L_GLU_c" stoichiometry="1"/>
     <speciesReference species="M H2O c" stoichiometry="1"/>
     <speciesReference species="M_NADP_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADPH_c" stoichiometry="1"/>
     <speciesReference species="M_AKG_c" stoichiometry="1"/>
     <speciesReference species="M_NH4_c" stoichiometry="1"/>
  /listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     /listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R203" name="L-Glutamate:NADP+ oxidoreductase (transaminating)" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1104
        SUBSYSTEM: Glutamate Metabolism 
        EC Number: 1.4.1.13
        Confidence Level: 1
```

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AUTHORS: Amino acid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADPH_c" stoichiometry="1"/>
     <speciesReference species="M_AKG_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M L GLU c" stoichiometry="2"/>
     <speciesReference species="M_NADP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R204" name="(S)-1-pyrroline-5-carboxylate:NAD+ oxidoreductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC1213
     SUBSYSTEM: Arginine and Proline Metabolism
     EC Number: 1.5.1.12
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_H2O_c" stoichiometry="2"/>
  <speciesReference species="M_NAD_c" stoichiometry="1"/>
  <speciesReference species="M PYRR5CARB c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_NADH_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

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</reaction>
<reaction id="R R205" name="L-Glutamate:ammonia ligase (ADP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0965
  SUBSYSTEM: Glutamate Metabolism 
  EC Number: 6.3.1.2
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M L GLN c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R206" name="L-glutamine:D-fructose-6-phosphate isomerase (deaminating)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1533
  SUBSYSTEM: Glutamate Metabolism 
  EC Number: 2.6.1.16
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
 <speciesReference species="M_F6P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_GLUSAP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
```

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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R207" name="D-Glycerate:NAD+ 2-oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC0431 or TTC0124)
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: (1.1.1.26 or 1.1.1.81)
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_HY_PYR_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_D_GLCT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R208" name="D-Glycerate:NADP+ 2-oxidoreductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0124
        SUBSYSTEM: Alternate Carbon Metabolism
        EC Number: 1.1.1.81
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADPH_c" stoichiometry="1"/>
     <speciesReference species="M_HY_PYR_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_NADP_c" stoichiometry="1"/>
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<speciesReference species="M_D_GLCT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R209" name="L-Serine:pyruvate aminotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1813
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 2.6.1.51
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 </listOfReactants>
```

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listOfProducts>
     <speciesReference species="M L ALA c" stoichiometry="1"/>
     <speciesReference species="M_HY_PYR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R210" name="3-Phospho-D-glycerate:NAD+ 2-oxidoreductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0586 or TTC1209)
        SUBSYSTEM: Glycine and Serine Metabolism
        EC Number: 1.1.1.95
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
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<speciesReference species="M_3PG_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_3POXPYR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R211" name="L-serine ammonia-lyase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE ASSOCIATION: ((TTC0387 or TTC0667) or TTC1708)
        SUBSYSTEM: Glycine and Serine Metabolism
        EC Number: (4.3.1.17 or 4.3.1.19)
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
```

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</notes>
   listOfReactants>
     <speciesReference species="M_L_SER_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PYR_c" stoichiometry="1"/>
     <speciesReference species="M_NH4_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R212" name="L-serine hydro-lyase [adding 1-C-(indol-3-yl)glycerol 3-phosphate" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0729 and TTC0730)
        SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
        EC Number: 4.2.1.20
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
```

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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_L_SER_c" stoichiometry="1"/>
     <speciesReference species="M_IND_GLYP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_L_TRP_c" stoichiometry="1"/>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_GAP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R213" name="5,10-Methylenetetrahydrofolate:glycine hydroxymethyltransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1160
        SUBSYSTEM: Glycine and Serine Metabolism
        EC Number: 2.1.2.1
```

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Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M L SER c" stoichiometry="1"/>
    <speciesReference species="M_THF_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R214" name="glycine:lipoylprotein oxidoreductase (decarboxylating and acceptor-aminomethylating)"
reversible="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
        GENE ASSOCIATION: (TTC0150 or TTC0151)
        SUBSYSTEM: Glycine and Serine Metabolism
        EC Number: 1.4.4.2
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
     <speciesReference species="M_LPP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_AMDHY_LPP_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
```

<reaction id="R\_R215" name="S-aminomethyldihydrolipoylprotein:(6S)-tetrahydrofolate aminomethyltransferase (ammonia-forming)" reversible="false">

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<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
      GENE ASSOCIATION: TTC0148
      SUBSYSTEM: Glycine and Serine Metabolism
      EC Number: 2.1.2.10
      Confidence Level: 1
      AUTHORS: Amino acid metabolism
      </body>
</notes>
listOfReactants>
  <speciesReference species="M_THF_c" stoichiometry="1"/>
  <speciesReference species="M_AMDHY_LPP_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_NH4_c" stoichiometry="1"/>
  <speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
  <speciesReference species="M_DHY_LPP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
      <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R216" name="dihydrolipoylprotein:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1700 or TTC1753)
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 1.8.1.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_DHY_LPP_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_LPP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R217" name="L-threonine acetaldehyde-lyase (glycine-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0397
   SUBSYSTEM: Threonine and Lysine Metabolism
   EC Number: 4.1.2.5
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_THR_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
 <speciesReference species="M_AALD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
```

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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R218" name="Acetyl-CoA:glycine C-acetyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1219
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 2.3.1.29
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_A_OXBUT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R219" name="L-threonine:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0201
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 1.1.1.103
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_THR_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M NADH c" stoichiometry="1"/>
 <speciesReference species="M_A_OXBUT_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R220" name="L-threonine ammonia-lyase (2-oxobutanoate-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1708
  SUBSYSTEM: Threonine and Lysine Metabolism
  EC Number: 4.3.1.19
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_THR_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
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<speciesReference species="M_AKB_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R221" name="O-phospho-L-homoserine phosphate-lyase (adding water;L-threonine-forming)"
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC0117
     SUBSYSTEM: Threonine and Lysine Metabolism
     EC Number: 4.2.3.1
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_OP_HSER_c" stoichiometry="1"/>
```

```
</listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_THR_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R222" name="ATP:L-homoserine O-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1028
  SUBSYSTEM: Threonine and Lysine Metabolism
  EC Number: 2.7.1.39
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M L HSER c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_OP_HSER_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R223" name="L-Homoserine:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0115
   SUBSYSTEM: Threonine and Lysine Metabolism
   EC Number: 1.1.1.3
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
```

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</body>
 </notes>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_ASP_4SA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_L_HSER_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R224" name="L-homoserine:NADP+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0115
   SUBSYSTEM: Threonine and Lysine Metabolism
   EC Number: 1.1.1.3
```

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Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_ASP_4SA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M NADP c" stoichiometry="1"/>
 <speciesReference species="M_L_HSER_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R225" name="L-Aspartate-4-semialdehyde:NADP+ oxidoreductase (phosphorylating)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC0177
     SUBSYSTEM: Threonine and Lysine Metabolism
     EC Number: 1.2.1.11
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_NADPH_c" stoichiometry="1"/>
  <speciesReference species="M 4P ASP c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_Pi_c" stoichiometry="1"/>
  <speciesReference species="M_NADP_c" stoichiometry="1"/>
  <speciesReference species="M_ASP_4SA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

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</reaction>
<reaction id="R R226" name="ATP:L-aspartate 4-phosphotransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0166
        SUBSYSTEM: Threonine and Lysine Metabolism
        EC Number: 2.7.2.4
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M 4P ASP c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R227" name="03-acetyl-L-serine:hydrogen-sulfide 2-amino-2-carboxyethyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1636
   SUBSYSTEM: Cysteine and methionine metabolism
   EC Number: 2.5.1.47
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_OAC_SER_c" stoichiometry="1"/>
 <speciesReference species="M_H2S_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_CYS_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R228" name="03-acetyl-L-serine:thiosulfate 2-amino-2-carboxyethyltransferase (reducing, L-cysteine-
forming)" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1636
     SUBSYSTEM: Cysteine and methionine metabolism
     EC Number: 2.5.1.47
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M_R_TRED_c" stoichiometry="1"/>
    <speciesReference species="M_OAC_SER_c" stoichiometry="1"/>
    <speciesReference species="M_TSFA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M L CYS c" stoichiometry="1"/>
    <speciesReference species="M_AC_c" stoichiometry="1"/>
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    <speciesReference species="M_SO3_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R229" name="L-cysteate:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1960
  SUBSYSTEM: Cysteine and methionine metabolism
  EC Number: 2.6.1.1
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_L_CYSTA_c" stoichiometry="1"/>
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 distOfProducts>
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<speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M SULFO PYR c" stoichiometry="1"/>
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 <listOfParameters>
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   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R230" name="3-sulfino-L-alanine:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1960
   SUBSYSTEM: Cysteine and methionine metabolism
   EC Number: 2.6.1.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_SLF_ALA_c" stoichiometry="1"/>
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</listOfReactants>
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 <speciesReference species="M_SULFI_PYR_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
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 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R231" name="L-Cysteine hydrogen-sulfide-lyase (deaminating" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1256
  SUBSYSTEM: Cysteine and methionine metabolism
  EC Number: 4.4.1.8
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
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<speciesReference species="M_L_CYS_c" stoichiometry="1"/>
     <speciesReference species="M H2O c" stoichiometry="1"/>
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  distOfProducts>
     <speciesReference species="M_PYR_c" stoichiometry="1"/>
     <speciesReference species="M_NH4_c" stoichiometry="1"/>
     <speciesReference species="M_H2S_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
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     definition of the control of
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        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R232" name="Acetyl-CoA:L-homoserine O-acetyltransferase" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0407
        SUBSYSTEM: Cysteine and methionine metabolism
        EC Number: 2.3.1.31
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
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</body>
           </notes>
           <speciesReference species="M_ACoA_c" stoichiometry="1"/>
             <speciesReference species="M_L_HSER_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_CoA_c" stoichiometry="1"/>
             <speciesReference species="M_OAC_HSER_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
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                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R233" name="O-acetyl-L-homoserine:hydrogen sulfide S-(3-amino-3-carboxypropyl)transferase"</pre>
reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: (TTC0408 or TTC0792)
                SUBSYSTEM: Cysteine and methionine metabolism
                EC Number: 2.5.1.49
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Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H2S_c" stoichiometry="1"/>
     <speciesReference species="M_OAC_HSER_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M AC c" stoichiometry="1"/>
     <speciesReference species="M_L_HCYS_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R234" name="L-cystathionine L-homocysteine-lyase (deaminating" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC1256
  SUBSYSTEM: Cysteine and methionine metabolism
  EC Number: 4.4.1.8
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_L_CYSTHNN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 <speciesReference species="M_L_HCYS_c" stoichiometry="1"/>
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 <listOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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<reaction id="R_R235" name="5-Methyltetrahydrofolate:L-homocysteine S-methyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0253
   SUBSYSTEM: Cysteine and methionine metabolism
   EC Number: 2.1.1.13
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_HCYS_c" stoichiometry="1"/>
 <speciesReference species="M 5MTHF c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_MET_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M THF c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R236" name="S-Adenosyl-L-homocysteine homocysteinylribohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1185
  SUBSYSTEM: Cysteine and methionine metabolism
  EC Number: 3.2.2.9
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_SAHC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADN_c" stoichiometry="1"/>
 <speciesReference species="M_RIBS_HCYS_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              /listOfParameters>
            </kineticLaw>
        </reaction>
        <reaction id="R_R237" name="S-(5-deoxy-D-ribos-5-yl)-L-homocysteine homocysteine-lyase [(4S)-4,5-dihydroxypentan-2,3-
dione-forming]" reversible="false">
            <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                  GENE ASSOCIATION: TTC1186
                  SUBSYSTEM: Cysteine and methionine metabolism
                  EC Number: 4.4.1.21
                  Confidence Level: 1
                  AUTHORS: Amino acid metabolism
                 </body>
            </notes>
            <speciesReference species="M_RIBS_HCYS_c" stoichiometry="1"/>
            </listOfReactants>
            distOfProducts>
              <speciesReference species="M_L_HCYS_c" stoichiometry="1"/>
              <speciesReference species="M_DHY_PENTDON_c" stoichiometry="1"/>
            </listOfProducts>
            <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                 <ci> FLUX_VALUE </ci>
              defined and the control of t
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R238" name="ATP:L-methionine S-adenosyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1279
   SUBSYSTEM: Cysteine and methionine metabolism
   EC Number: 2.5.1.6
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_MET_c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_SAM_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R R239" name="S-adenosyl-L-methionine carboxy-lyase [(5-deoxy-5-adenosyl)(3-
aminopropyl)methylsulfonium-forming]" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC0473 or TTC1093)
     SUBSYSTEM: Cysteine and methionine metabolism
     EC Number: 4.1.1.50
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M SAM c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_CO2_c" stoichiometry="1"/>
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<speciesReference species="M_SAMA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 distOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R240" name="S-adenosylmethioninamine:putrescine 3-aminopropyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0472
  SUBSYSTEM: Cysteine and methionine metabolism
  EC Number: 2.5.1.16
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SAMA_c" stoichiometry="1"/>
 <speciesReference species="M PUT c" stoichiometry="1"/>
 </listOfReactants>
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distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_MTA_c" stoichiometry="1"/>
 <speciesReference species="M_SPRD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R241" name="S-adenosylmethioninamine:spermidine 3-aminopropyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0472
  SUBSYSTEM: Cysteine and methionine metabolism
  EC Number: 2.5.1.16
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
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<speciesReference species="M_SAMA_c" stoichiometry="1"/>
     <speciesReference species="M SPRD c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_MTA_c" stoichiometry="1"/>
     <speciesReference species="M_SPR_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R242" name="Methylthioadenosine methylthioribohydrolase" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1185
        SUBSYSTEM: Cysteine and methionine metabolism
        EC Number: 3.2.2.9
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_MTA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADN_c" stoichiometry="1"/>
     <speciesReference species="M_MTH_RIB_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R243" name="5-Methylthio-5-deoxy-D-ribose-1-phosphate ketol-isomerase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0707
        SUBSYSTEM: Cysteine and methionine metabolism
        EC Number: 5.3.1.23
        Confidence Level: 1
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AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_MTh_RIB1P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_MTh_RIBL1P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R244" name="L-Leucine:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1870
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 2.6.1.42
   Confidence Level: 1
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AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_4M_2OPENTN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_LEU_c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R245" name="L-Valine:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1870
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
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EC Number: 2.6.1.42
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_VAL_c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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 <speciesReference species="M_2K3M_BUT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R246" name="L-Isoleucine:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

```
GENE_ASSOCIATION: TTC1870
  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
  EC Number: 2.6.1.42
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M_L_ILE_c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_3M_2OPENTN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R247" name="branched-chain alpha-keto acid dehydrogenase" reversible="false">
```

```
<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC1756 and TTC1757)
     SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
     EC Number: 1.2.4.4
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_3M_2OPENTN_c" stoichiometry="1"/>
  <speciesReference species="M_TPP_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_CO2_c" stoichiometry="1"/>
  <speciesReference species="M_2MHYBUT_ThPP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R248" name="branched-chain alpha-keto acid dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1756 and TTC1757)
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.2.4.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_4M_2OPENTN_c" stoichiometry="1"/>
 <speciesReference species="M_TPP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M 3MHYBUT ThPP c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

```
/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R249" name="branched-chain alpha-keto acid dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1756 and TTC1757)
  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
  EC Number: 1.2.4.4
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_2K3M_BUT_c" stoichiometry="1"/>
 <speciesReference species="M_TPP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_2MHYPROP_ThPP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

```
<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R250" name="branched-chain alpha-keto acid dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1756 and TTC1757)
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.2.4.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_2MHYPROP_ThPP_c" stoichiometry="1"/>
 <speciesReference species="M ENZN6 LPL c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_TPP_c" stoichiometry="1"/>
 <speciesReference species="M_DHYLPL_MPROP_MPROP_DHLPL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

```
<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R251" name="branched-chain alpha-keto acid dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1756 and TTC1757)
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.2.4.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_3MHYBUT_ThPP_c" stoichiometry="1"/>
 <speciesReference species="M_ENZN6_LPL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_TPP_c" stoichiometry="1"/>
 <speciesReference species="M_DHYLPL_MPROP_3MBUT_DHLPL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R252" name="branched-chain alpha-keto acid dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1756 and TTC1757)
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.2.4.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_2MHYBUT_ThPP_c" stoichiometry="1"/>
 <speciesReference species="M_ENZN6_LPL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_TPP_c" stoichiometry="1"/>
 <speciesReference species="M_DHYLPL_MPROP_2MBUT_DHLPL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R253" name="(S)-2-methylbutanoyl-CoA:acceptor 2,3-oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0238
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.3.8.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_FAD_c" stoichiometry="1"/>
 <speciesReference species="M_MBUTNCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M FADH2 c" stoichiometry="1"/>
 <speciesReference species="M_MBUT_ENCoA_c" stoichiometry="1"/>
```

```
</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R254" name="2-methylpropanoyl-CoA:(acceptor) 2,3-oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0238
  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
  EC Number: 1.3.8.1
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_FAD_c" stoichiometry="1"/>
 <speciesReference species="M_2M_PROCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_FADH2_c" stoichiometry="1"/>
 <speciesReference species="M MACRYCOA c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R255" name="(2S,3S)-3-Hydroxy-2-methylbutanoyl-CoA hydro-liase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1768
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 4.2.1.17
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_MBUT_ENCoA_c" stoichiometry="1"/>
```

```
</listOfReactants>
   distOfProducts>
     <speciesReference species="M_HY_MBUTRCoA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R256" name="(S)-3-Hydroxyisobutyryl-CoA hydro-lyase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC1768
         SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
         EC Number: 4.2.1.17
         Confidence Level: 1
         AUTHORS: Amino acid metabolism
         </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
```

```
<speciesReference species="M_MACRYCoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_HYIBUTRCoA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R257" name="(S)-3-hydroxy-3-methylglutaryl-CoA acetoacetate-lyase (acetyl-CoA-forming)"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1162
     SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
     EC Number: 4.1.3.4
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
```

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listOfReactants>
     <speciesReference species="M HYM GLUTRCoA c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ACoA_c" stoichiometry="1"/>
     <speciesReference species="M_AAC_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R258" name="3-Hydroxy-2-methylpropanoate:NAD+ oxidoreductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC1749 or TTC0534)
        SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
        EC Number: 1.1.1.31 or 1.1.1.35
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
```

```
</notes>
  listOfReactants>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_HYIBUTRA_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_MMAL_SA_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     /listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R259" name="(S)-Methylmalonate semialdehyde:NAD+ oxidoreductase" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0513
        SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
        EC Number: 1.2.1.3
        Confidence Level: 1
```

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AUTHORS: Amino acid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_MMAL_SA_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M NADH c" stoichiometry="1"/>
     <speciesReference species="M_MMAL_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R260" name="acetyl-CoA:propanoyl-CoA 2-C-acetyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: ((TTC0535 or TTC0623) or (TTC0191 or TTC0330))
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 2.3.1.16 or 2.3.1.9
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_MAACCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 <speciesReference species="M_PRCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R261" name="(R)-Methylmalonyl-CoA CoA-carbonylmutase" reversible="true">
```

```
<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0676 and (TTC0677 or TTC0882))
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 5.4.99.2
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_R_MMALCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_SUCCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R262" name="Propanoyl-CoA:carbon-dioxide ligase (ADP-forming)" reversible="false">
```

```
<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: (TTC0783 and TTC1192)
 SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
 EC Number: 6.4.1.3
 Confidence Level: 1
 AUTHORS: Amino acid metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_ATP_c" stoichiometry="1"/>
<speciesReference species="M_HCO3_c" stoichiometry="1"/>
<speciesReference species="M_PRCoA_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_ADP_c" stoichiometry="1"/>
<speciesReference species="M_Pi_c" stoichiometry="1"/>
<speciesReference species="M H c" stoichiometry="1"/>
<speciesReference species="M_MMALCoA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
listOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R263" name="4-hydroxy-tetrahydrodipicolinate synthase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0591
   SUBSYSTEM: Threonine and Lysine Metabolism
   EC Number: 4.2.1.52
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_ASP_4SA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="2"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_DHY_DPICLN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
               <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
            </listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R_R264" name="UDP-N-acetylmuramoyl-L-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioate:D-alanyl-D-glutamyl-meso-2,6-diaminoheptanedioa
alanine ligase(ADP-forming)" reversible="false">
          <notes>
            <body xmlns="http://www.w3.org/1999/xhtml">
               GENE ASSOCIATION: TTC0714
               SUBSYSTEM: Cell Envelope Biosynthesis
               EC Number: 6.3.2.10
               Confidence Level: 1
               AUTHORS: Lipid metabolism
               </body>
          </notes>
          distOfReactants>
            <speciesReference species="M_ATP_c" stoichiometry="1"/>
            <speciesReference species="M_UDP_ACMUR_ALA_GLU_DAPIM_c" stoichiometry="1"/>
            <speciesReference species="M_D_ALA_D_ALA_c" stoichiometry="1"/>
          </listOfReactants>
          distOfProducts>
            <speciesReference species="M ADP c" stoichiometry="1"/>
            <speciesReference species="M_Pi_c" stoichiometry="1"/>
            <speciesReference species="M_H_c" stoichiometry="1"/>
            <speciesReference species="M_UDP_ACMUR_ALA_GLU_DAPIM_ALA_ALA_c" stoichiometry="1"/>
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</listOfProducts>
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    <listOfParameters>
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     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R R265" name="UDP-N-acetylmuramoyl-L-alanyl-D-glutamate:(L)-meso-2,6-diaminoheptanedioate gamma-
ligase (ADP-forming)" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1904
     SUBSYSTEM: Cell Envelope Biosynthesis
     EC Number: 6.3.2.13
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_UDP_ACMURM_ALA_GLUT_c" stoichiometry="1"/>
    <speciesReference species="M_M26_DAP_c" stoichiometry="1"/>
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</listOfReactants>
   distOfProducts>
    <speciesReference species="M_ADP_c" stoichiometry="1"/>
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    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M_UDP_ACMUR_ALA_GLU_DAPIM_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
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    IistOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R266" name="acetyl-CoA:2-oxoglutarate C-acetyltransferase (thioester-hydrolysing, carboxymethyl</p>
forming)" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1550
     SUBSYSTEM: Threonine and Lysine Metabolism
     EC Number: 2.3.3.14
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
```

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</body>
           </notes>
           listOfReactants>
             <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M_ACoA_c" stoichiometry="1"/>
             <speciesReference species="M_AKG_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_CoA_c" stoichiometry="1"/>
             <speciesReference species="M_HCIT_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             </listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R267" name="(1R,2S)-1-hydroxybutane-1,2,4-tricarboxylate:NAD+ oxidoreductase (decarboxylating)"</pre>
reversible="true">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: TTC1012
                SUBSYSTEM: Threonine and Lysine Metabolism
```

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EC Number: 1.1.1.87
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_OXLGLUTR_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
    <speciesReference species="M_CO2_c" stoichiometry="1"/>
    <speciesReference species="M 2OADPA c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R268" name="(1R,2S)-1-hydroxybutane-1,2,4-tricarboxylate:NAD+ oxidoreductase (decarboxylating)"</pre>
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC1012
  SUBSYSTEM: Threonine and Lysine Metabolism
  EC Number: 1.1.1.87
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_HICTR_c" stoichiometry="1"/>
 </listOfReactants>
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 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_OXLGLUTR_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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<reaction id="R_R269" name="L-2-aminoadipate:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0043
   SUBSYSTEM: Threonine and Lysine Metabolism
   EC Number: 2.6.1.39
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_AADP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_2OADPA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 distOfParameters>
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   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R270" name="N-acetylaminoadipate kinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1541 or TTC1586)
  SUBSYSTEM: Threonine and Lysine Metabolism
  EC Number: 2.7.2.- 
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_AC_AADP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M ADP c" stoichiometry="1"/>
 <speciesReference species="M_AC_AADP_DELPi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R271" name="N-acetyl-alpha-aminoadipate-phosphate reductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0386 or TTC1542)
   SUBSYSTEM: Threonine and Lysine Metabolism
   EC Number: 1.2.1.38
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M AC AADP DELPi c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_AC_AADP_SA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R272" name="N2-acetyl-L-lysine deacetylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1396
   SUBSYSTEM: Threonine and Lysine Metabolism
   EC Number: 3.5.1.-
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_N2AC_L_LYS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_LYS_c" stoichiometry="1"/>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
    distOfParameters>
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     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R R273" name="2-Oxoadipate:lipoamde 2-oxidoreductase(decarboxylating and acceptor-succinylating)"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1698
     SUBSYSTEM: Threonine and Lysine Metabolism
     EC Number: 1.2.4.2
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_ENZN6_LPL_c" stoichiometry="1"/>
    <speciesReference species="M_2OADPA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_CO2_c" stoichiometry="1"/>
    <speciesReference species="M_DHLPL_SUCCT_GLUTRDHLPL_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R274" name="Glutaryl-CoA:dihydrolipoamide S-succinyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1699
  SUBSYSTEM: Threonine and Lysine Metabolism
  EC Number: 2.3.1.61
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M_GLUTRCoA_c" stoichiometry="1"/>
 <speciesReference species="M_ENZNE_DHYLPL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M DHLPL SUCCT GLUTRDHLPL c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R275" name="4-Trimethylammoniobutanal:NAD+ 1-oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC0513
  SUBSYSTEM: Threonine and Lysine Metabolism
  EC Number: 1.2.1.3
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
```

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<speciesReference species="M_TM_AMBUTAL_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M_NADH_c" stoichiometry="1"/>
    <speciesReference species="M_TM_AMBUTAT_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R276" name="1-(5-phospho-D-ribosyl)-ATP:diphosphate phospho-alpha-D-ribosyl-transferase"</pre>
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1866
     SUBSYSTEM: Histidine Metabolism
     EC Number: 2.4.2.17
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
```

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</body>
 </notes>
 distOfReactants>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_PRIB_ATP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_PRPP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R277" name="Phosphoribosyl-ATP pyrophosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1080
   SUBSYSTEM: Histidine Metabolism
   EC Number: 3.6.1.31
   Confidence Level: 1
```

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AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_PRIB_ATP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M PRIB AMP c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R278" name="1-(5-phospho-D-ribosyl)-AMP 1,6-hydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1080
```

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SUBSYSTEM: Histidine Metabolism
     EC Number: 3.5.4.19
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_PRIB_AMP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_PRINS_AFORMA_PRIBS_IMDZ_CARBA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R279" name="N-(5&apos;-Phospho-D-ribosylformimino)-5-amino-1- (5&apos;-phospho-D-ribosyl)-4-
imidazolecarboxamide ketol-isomerase" reversible="true">
   <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
        GENE ASSOCIATION: TTC0801
        SUBSYSTEM: Histidine Metabolism
        EC Number: 5.3.1.16
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_PRINS_AFORMA_PRIBS_IMDZ_CARBA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M PRINSFORMA PRIBS IMDZ CARBA c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     defined and the control of t
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R280" name="Imidazole-glycerol-3-phosphate synthase" reversible="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: (TTC0062 and TTC1079)
     SUBSYSTEM: Histidine Metabolism
     EC Number: 2.4.2.- or 4.1.3.-
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
distOfReactants>
  <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
  <speciesReference species="M PRINSFORMA PRIBS IMDZ CARBA c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_AICAR_c" stoichiometry="1"/>
  <speciesReference species="M_ERY_IMDZ_GLYCP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
  </listOfParameters>
```

```
</kineticLaw>
</reaction>
<reaction id="R_R281" name="D-erythro-1-(Imidazol-4-yl)glycerol 3-phosphate hydro-lyase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0061
        SUBSYSTEM: Histidine Metabolism
        EC Number: 4.2.1.19
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_ERY_IMDZ_GLYCP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M IMDZ ACLP c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R282" name="5-Amino-2-oxopentanoate:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0060 or TT_P0022)
  SUBSYSTEM: Histidine Metabolism
  EC Number: 2.6.1.9
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_HISDPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_IMDZ_ACLP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R283" name="L-Histidinol-phosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1652
   SUBSYSTEM: Histidine Metabolism
   EC Number: 3.1.3.15
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M HISDPi c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_L_HISN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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```
<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R284" name="L-Histidinol:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0370
   SUBSYSTEM: Histidine Metabolism
   EC Number: 1.1.1.23
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="2"/>
 <speciesReference species="M_L_HISN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_HIS_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="3"/>
 <speciesReference species="M_NADH_c" stoichiometry="2"/>
 </listOfProducts>
 <kineticLaw>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R285" name="L-histidinal:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0370
   SUBSYSTEM: Histidine Metabolism
   EC Number: 1.1.1.23
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_L_HISDAL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_HIS_c" stoichiometry="1"/>
```

```
<speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M NADH c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R286" name="Imidazole acetaldehyde:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC0513
  SUBSYSTEM: Histidine Metabolism
  EC Number: 1.2.1.3
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
```

```
<speciesReference species="M_IMDZ_AALD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_IMDZ_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R287" name="p-hydroxyphenylpyruvate oxidase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 1.2.3.13
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
```

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</notes>
  distOfReactants>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_O2_c" stoichiometry="1"/>
     <speciesReference species="M_HYPh_PYR_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_HY_PhAC_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     defined and the control of t
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R288" name="4-hydroxyphenylacetate,NADH:oxygen oxidoreductase (3-hydroxylating)" reversible="true">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0594
        SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
        EC Number: 1.14.14.9
```

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Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_HY_PhAC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_dHY_PhAC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R289" name="3,4-dihydroxyphenylacetate dioxygenase" reversible="false">
```

```
<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: 
     SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
     EC Number: 1.13.11.15
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_O2_c" stoichiometry="1"/>
  <speciesReference species="M_dHY_PhAC_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_2HY_5CARBMMUC_SA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R290" name="5-carboxymethyl-2-hydroxymuconic-semialdehyde:NAD+ oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0593
  SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
  EC Number: 1.2.1.60
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_2HY_5CARBMMUC_SA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_CARBM_HYMUC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

```
<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R291" name="5-carboxymethyl-2-hydroxymuconate isomerase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
  EC Number: 5.3.3.10
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CARBM_HYMUC_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_CRBX_OHEPTEDA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

```
<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R292" name="5-oxopent-3-ene-1,2,5-tricarboxylate carboxy-lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0592
  SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
  EC Number: 4.1.1.68
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M CRBX OHEPTEDA c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_HYHEPTDENA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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```
<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R293" name="2-hydroxyhepta-2,4-dienedioate hydratase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 5.3.3.-
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_OHEPEDA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_HYHEPTDENA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
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```
<listOfParameters>
   <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R294" name="4-hydroxy-2-ketopimelate aldolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 4.1.2.-
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_OHEPEDA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_SUCC_SA_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R295" name="L-tyrosine:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1960
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 2.6.1.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_TYR_c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_HYPh_PYR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R296" name="Phenylacetate:CoA ligase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0602
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 6.2.1.30
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_PhAC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
```

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<speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M PhACoA c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R297" name="L-Phenylalanine:2-oxoglutarate aminotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1960
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 2.6.1.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_PHE_c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_PPYR_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R298" name="Phenylpyruvate decarboxylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
  EC Number: 4.1.1.43
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M PPYR c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_PhALD_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R299" name="Phenylacetaldehyde dehydrogease" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
        EC Number: 1.2.1.39
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
```

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</notes>
  listOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_PhALD_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_PhAC_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R300" name="phenylacetate-CoA oxygenase" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0608
        SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
        EC Number: 1.14.13.149
```

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Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_PhACoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_dhPhACoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R301" name="1,2-epoxyphenylacetyl-CoA isomerase" reversible="true">
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<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1697
  SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
  EC Number: 5.3.3.18
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_dhPhAC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_OPACCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 IistOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R302" name="oxepin-CoA hydrolase" reversible="false">
```

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<notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC0604
         SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
         EC Number: 3.7.1.16
         Confidence Level: 1
         AUTHORS: Amino acid metabolism
         </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_OPACCoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ODHSCoASA_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
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<reaction id="R_R303" name="3-oxo-5,6-dehydrosuberyl-CoA semialdehyde dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0604
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 1.17.1.17
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_ODHSCoASA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M NADPH c" stoichiometry="1"/>
 <speciesReference species="M_ODHSCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R304" name="beta-ketoadipyl CoA thiolase" reversible="false">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC0623
         SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
         EC Number: 2.3.1.-
         Confidence Level: 1
         AUTHORS: Amino acid metabolism
         </body>
   </notes>
   distOfReactants>
      <speciesReference species="M_CoA_c" stoichiometry="1"/>
      <speciesReference species="M_ODHSCoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_ACoA_c" stoichiometry="1"/>
      <speciesReference species="M_DHADPCoA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R305" name="enoyl-CoA hydratase " reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0604 or TTC1697 or TTC1768)
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 4.2.1.17
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M DHADPCoA c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_HADPCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R306" name="3-hydroxyacyl-CoA dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC0331 or TTC0534)
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 1.1.1.35
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_HADPCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_OADPCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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```
<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R307" name="beta-ketoadipyl CoA thiolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0623
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 2.3.1.174
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_OADPCoA_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 <speciesReference species="M SUCCoA c" stoichiometry="1"/>
 </listOfProducts>
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<kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R308" name="2-oxoadipate dehydrogenase complex" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC1698 or (TTC1700 or TTC1753) or TTC1699)
        SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
        EC Number: 1.2.4.2 or 1.8.1.4 or 2.3.1.61
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_CoA_c" stoichiometry="1"/>
     <speciesReference species="M_2OADPA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
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<speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M NADH c" stoichiometry="1"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_GLUTRCoA_c" stoichiometry="1"/>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R309" name="L-aspartate 1-carboxy-lyase (beta-alanine-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0241
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 4.1.1.11
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_L_ASP_c" stoichiometry="1"/>
     <speciesReference species="M H c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_B_ALA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R310" name="beta-alanine:2-oxoglutarate aminotransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0510
        SUBSYSTEM: Beta-Alanine metabolism 
        EC Number: 2.6.1.19
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
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</notes>
 distOfReactants>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_B_ALA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_MAL_SA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R311" name="malonate-semialdehyde dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Beta-Alanine metabolism 
   EC Number: 1.2.1.-
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_MAL_SA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M ACoA c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R312" name="(R)-Pantoate:beta-alanine ligase (AMP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1416
```

```
SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 6.3.2.1
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_B_ALA_c" stoichiometry="1"/>
  <speciesReference species="M_PANTA_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_AMP_c" stoichiometry="1"/>
  <speciesReference species="M_PANTO_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R313" name="UDP-N-acetylmuramate:L-alanine ligase (ADP-forming)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC0720
         SUBSYSTEM: Cell Envelope Biosynthesis
         EC Number: 6.3.2.8
         Confidence Level: 1
         AUTHORS: Lipid metabolism
         </body>
   </notes>
   <speciesReference species="M_L_ALA_c" stoichiometry="1"/>
     <speciesReference species="M_UDP_ACMURM_c" stoichiometry="1"/>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M ADP c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_UDP_ACMURM_ALA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R314" name="UDP-N-acetylmuramoyl-L-alanine:D-glutamate ligase(ADP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0717
   SUBSYSTEM: Cell Envelope Biosynthesis
   EC Number: 6.3.2.9
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M D GLU c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_ACMURM_ALA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_ACMURM_ALA_GLUT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R315" name="glutamate racemase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1280
  SUBSYSTEM: Cell Envelope Biosynthesis
  EC Number: 5.1.1.3
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GLU_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R316" name="alanine racemase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC1944
         SUBSYSTEM: Alanine and Aspartate Metabolism
         EC Number: 5.1.1.1
         Confidence Level: 1
         AUTHORS: Amino acid metabolism
         </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_L_ALA_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_D_ALA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R317" name="D-alanine:D-alanine ligase (ADP-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1223
   SUBSYSTEM: Cell Envelope Biosynthesis
   EC Number: 6.3.2.4
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_D_ALA_c" stoichiometry="2"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
```

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<speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M D ALA D ALA c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R318" name="(2R,3S)-3-methylmalate:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0867
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.1.1.85
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_IPROP_MAL_c" stoichiometry="1"/>
```

```
</listOfReactants>
           distOfProducts>
             <speciesReference species="M_H_c" stoichiometry="1"/>
             <speciesReference species="M_NADH_c" stoichiometry="1"/>
             <speciesReference species="M_CO2_c" stoichiometry="1"/>
             <speciesReference species="M_AKB_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R319" name="(R)-2,3-Dihydroxy-3-methylbutanoate:NADP+ oxidoreductase (isomerizing)"</pre>
reversible="true">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: TTC0850
                SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
                EC Number: 1.1.1.86
                Confidence Level: 1
                AUTHORS: Amino acid metabolism
```

```
</body>
           </notes>
           <speciesReference species="M_NADP_c" stoichiometry="1"/>
             <speciesReference species="M_RDHY_MBUTNA_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_H_c" stoichiometry="1"/>
             <speciesReference species="M_NADPH_c" stoichiometry="1"/>
             <speciesReference species="M_3HY_2M_2OBUTNA_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             </listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R320" name="(R)-2,3-Dihydroxy-3-methylpentanoate:NADP+ oxidoreductase (isomerizing)"</pre>
reversible="true">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE ASSOCIATION: TTC0850
                SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
```

```
EC Number: 1.1.1.86
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_NADP_c" stoichiometry="1"/>
     <speciesReference species="M_DHY_MPENTA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADPH_c" stoichiometry="1"/>
     <speciesReference species="M_AC_HYBUTNA_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R321" name="(S)-2-Acetolactate methylmutase" reversible="true">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
        GENE ASSOCIATION: TTC0850
        SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
        EC Number: 1.1.1.86
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_S_ACLAC_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M 3HY 2M 2OBUTNA c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R322" name="(R)-2,3-Dihydroxy-3-methylpentanoate hydro-lyase" reversible="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC0871
  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
  EC Number: 4.2.1.9
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_DHY_MPENTA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_3M_2OPENTN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R323" name="(R)-2,3-Dihydroxy-3-methylbutanoate hydro-lyase" reversible="false">
```

```
<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0871
  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
  EC Number: 4.2.1.9
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_RDHY_MBUTNA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_2K3M_BUT_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

<reaction id="R\_R324" name="acetyl-CoA:3-methyl-2-oxobutanoate C-acetyltransferase (thioester-hydrolysing, carboxymethyl-forming)" reversible="false">

```
<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
      GENE ASSOCIATION: (TTC0847 or TTC0849)
      SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
      EC Number: 2.3.3.13
      Confidence Level: 1
      AUTHORS: Amino acid metabolism
      </body>
</notes>
listOfReactants>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M_ACoA_c" stoichiometry="1"/>
  <speciesReference species="M_2K3M_BUT_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_CoA_c" stoichiometry="1"/>
  <speciesReference species="M_IPRO_MAL_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
      <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

```
<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R325" name="2-Isopropylmalate hydro-lyase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: ((TTC0865 and TTC0866) or (TTC1546 and TTC1547))
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 4.2.1.33
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_IPRO_MAL_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_IPRO_MALE_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R326" name="3-Isopropylmalate hydro-lyase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: ((TTC0865 and TTC0866) or (TTC1546 and TTC1547))
  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
  EC Number: 4.2.1.33
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M IPROP MAL c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_IPRO_MALE_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

```
<parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R327" name="(2R,3S)-3-isopropylmalate:NAD+ oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0867
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.1.1.85
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_IPROP_MAL_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_IPROP_OSUCC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

```
<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R328" name="acetyl-CoA:L-glutamate N-acetyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC0835 or TTC1703)
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 2.3.1.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M CoA c" stoichiometry="1"/>
 <speciesReference species="M_AC_GLUT_c" stoichiometry="1"/>
```

```
</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R329" name="ATP:N-acetyl-L-glutamate 5-phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1541 or TTC1586)
  SUBSYSTEM: Arginine and Proline Metabolism
  EC Number: 2.7.2.8
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_AC_GLUT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_ADP_c" stoichiometry="1"/>
    <speciesReference species="M AC GLUTPi c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R330" name="N-acetyl-L-glutamate-5-semialdehyde:NADP+ 5-oxidoreductase (phosphrylating)"</pre>
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC0836 or TTC1542)
     SUBSYSTEM: Arginine and Proline Metabolism
     EC Number: 1.2.1.38
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H_c" stoichiometry="1"/>
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<speciesReference species="M_NADPH_c" stoichiometry="1"/>
     <speciesReference species="M AC GLUTPi c" stoichiometry="1"/>
  </listOfReactants>
  listOfProducts>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_NADP_c" stoichiometry="1"/>
     <speciesReference species="M_AC_GLUT_SA_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R331" name="N2-Acetyl-L-ornithine:2-oxoglutarate aminotransferase" reversible="true">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1393
        SUBSYSTEM: Arginine and Proline Metabolism
        EC Number: 2.6.1.11
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
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</body>
 </notes>
 distOfReactants>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_AORT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_AC_GLUT_SA_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R332" name="L-Glutamate 5-semialdehyde:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1213
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 1.5.1.12
   Confidence Level: 1
```

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AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
  <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_NADH_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M NAD c" stoichiometry="1"/>
  <speciesReference species="M_GLUT_SA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
  distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R333" name="L-glutamate-5-semialdehyde:NADP+ 5-oxidoreductase (phosphorylating)" reversible="false">
 <notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC1564
     SUBSYSTEM: Arginine and Proline Metabolism
     EC Number: 1.2.1.41
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_NADPH_c" stoichiometry="1"/>
  <speciesReference species="M L GLUT5P c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_Pi_c" stoichiometry="1"/>
  <speciesReference species="M_NADP_c" stoichiometry="1"/>
  <speciesReference species="M_GLUT_SA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R334" name="ATP:L-glutamate 5-phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1563
        SUBSYSTEM: Arginine and Proline Metabolism
        EC Number: 2.7.2.11
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M L GLUT5P c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R335" name="N2-Acetyl-L-ornithine:L-glutamate N-acetyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0835
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 2.3.1.35
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_AORT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ORT_c" stoichiometry="1"/>
 <speciesReference species="M_AC_GLUT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R336" name="N2-Acetyl-L-ornithine amidohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0133 or TTC1460)
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 3.5.1.14
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M AORT c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ORT_c" stoichiometry="1"/>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R337" name="Carbamoyl-phosphate:L-ornithine carbamoyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0838
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 2.1.3.3
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ORT_c" stoichiometry="1"/>
 <speciesReference species="M_CARB_Pi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CTRLN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

```
<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R338" name="L-Arginine amidinohydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1132
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 3.5.3.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_ARG_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ORT_c" stoichiometry="1"/>
 <speciesReference species="M UREA c" stoichiometry="1"/>
 </listOfProducts>
```

```
<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R339" name="urea-1-carboxylate amidohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0624
  SUBSYSTEM: Arginine and Proline Metabolism
  EC Number: 3.5.1.54
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UREA_CARB_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_CO2_c" stoichiometry="2"/>
 <speciesReference species="M NH4 c" stoichiometry="2"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R340" name="L-Proline:NAD+ 5-oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC0500
  SUBSYSTEM: Arginine and Proline Metabolism
  EC Number: 1.5.1.2
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_PRO_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
```

```
</listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_PYRR5CARB_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R341" name="L-Proline:NADP+ 5-oxidoreductase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0500
        SUBSYSTEM: Arginine and Proline Metabolism
        EC Number: 1.5.1.2
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
```

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listOfReactants>
 <speciesReference species="M L PRO c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_PYRR5CARB_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R342" name="4-hydroxyproline degradation I " reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: spontaneous
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PYRR_3HY_5CARB_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="2"/>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_HYGLU_SA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R343" name="L-erythro-4-Hydroxyglutamate:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1213 or TTC1214)
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: (1.5.1.12 or 1.5.99.8)
```

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Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_HYGLU_SA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_ERY_HYGLU_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R344" name="L-1-Pyrroline-3-hydroxy-5-carboxylate:NAD+ oxidoreductase" reversible="false">
 <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC1213
     SUBSYSTEM: Arginine and Proline Metabolism
     EC Number: 1.5.1.12
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
distOfReactants>
  <speciesReference species="M_H2O_c" stoichiometry="2"/>
  <speciesReference species="M NAD c" stoichiometry="1"/>
  <speciesReference species="M_PYRR_3HY_5CARB_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_NADH_c" stoichiometry="1"/>
  <speciesReference species="M_ERY_HYGLU_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
  </listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R345" name="putrescine:2-oxoglutarate aminotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0553
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 2.6.1.82
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_PUT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_4ABUTALD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R346" name="4-aminobutanal:NAD+ 1-oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0513
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 1.2.1.3
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M 4ABUTALD c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_4ABUT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
```

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<parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R347" name="trans-4-Hydroxy-L-proline:NAD+ 5-oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0500
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 1.5.1.2
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_PYRR_3HY_5CARB_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_tHY_PRO_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

<listOfParameters>

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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R348" name="trans-4-Hydroxy-L-proline:NADP+ 5-oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0500
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 1.5.1.2
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_PYRR_3HY_5CARB_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
```

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<speciesReference species="M_tHY_PRO_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R349" name="proline 4-hydroxylase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Arginine and Proline Metabolism
  EC Number: 1.14.11.-
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_PRO_c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
```

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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_SUCC_c" stoichiometry="1"/>
 <speciesReference species="M_tHY_PRO_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R350" name="L-erythro-4-hydroxyglutamate:2-oxoglutarate aminotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1960
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 2.6.1.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
```

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listOfReactants>
     <speciesReference species="M AKG c" stoichiometry="1"/>
     <speciesReference species="M_ERY_HYGLU_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
     <speciesReference species="M_HY_OGLUTR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R351" name="D-4-Hydroxy-2-oxoglutarate glyoxylate-lyase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TT_P0030
        SUBSYSTEM: Arginine and Proline Metabolism
        EC Number: 4.1.2.14
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
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</body>
 </notes>
 <speciesReference species="M_HY_OGLUTR_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_GLOXT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R352" name="Agmatine amidinohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0764
  SUBSYSTEM: Arginine and Proline Metabolism
  EC Number: 3.5.3.11
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_AGMT_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PUT_c" stoichiometry="1"/>
     <speciesReference species="M_UREA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R353" name="L-arginine carboxy-lyase (agmatine-forming)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1277
        SUBSYSTEM: Arginine and Proline Metabolism
        EC Number: 4.1.1.19
```

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Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_L_ARG_c" stoichiometry="1"/>
    <speciesReference species="M_H_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
    <speciesReference species="M_CO2_c" stoichiometry="1"/>
    <speciesReference species="M AGMT c" stoichiometry="1"/>
   </or>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R354" name="2-Dehydro-3-deoxy-D-arabino-heptonate 7-phosphate phosphate-lyase (cyclyzing)"</p>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC1020
  SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
  EC Number: 4.2.3.4
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_DHYDO_ARAB_HEPTP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_3DHYQNT_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R355" name="3-Dehydroquinate hydro-lyase" reversible="false">
 <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC0989
  SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
  EC Number: 4.2.1.10
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M_3DHYQNT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_DHY_SHK_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R356" name="ATP:shikimate 3-phosphotransferase" reversible="false">
```

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<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: TTC1019
 SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
 EC Number: 2.7.1.71
 Confidence Level: 1
 AUTHORS: Amino acid metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_ATP_c" stoichiometry="1"/>
<speciesReference species="M_SHK_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
<speciesReference species="M_ADP_c" stoichiometry="1"/>
<speciesReference species="M_H_c" stoichiometry="1"/>
<speciesReference species="M_SHKP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
distOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
/listOfParameters>
```

```
</kineticLaw>
  </reaction>
  <reaction id="R_R357" name="Phosphoenolpyruvate:3-phosphoshikimate 5-O-(1-carboxyvinyl)-transferase"</pre>
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0088
     SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
     EC Number: 2.5.1.19
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_PEP_c" stoichiometry="1"/>
    <speciesReference species="M_SHKP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_Pi_c" stoichiometry="1"/>
    <speciesReference species="M_CVP_SHK_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    listOfParameters>
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R358" name="5-O-(1-Carboxyvinyl)-3-phosphoshikimate phosphate-lyase (chorismate-forming)"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: (TTC0518 or TTC1018)
     SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
     EC Number: 4.2.3.5
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   <speciesReference species="M_CVP_SHK_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_Pi_c" stoichiometry="1"/>
    <speciesReference species="M_CORM_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    listOfParameters>
```

```
<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R359" name="Chorismate pyruvate-lyase (amino-accepting)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC1492 and TTC1493)
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 4.1.3.27
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
 <speciesReference species="M_CORM_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_ANTHRL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R360" name="L-serine hydro-lyase (adding indole" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0729 and TTC0730)
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 4.2.1.20
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 <speciesReference species="M_IND_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_TRP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
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</listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                 <ci> FLUX_VALUE </ci>
              definition of the control of
                 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R361" name="(15,2R)-1-C-(indol-3-yl)glycerol 3-phosphate D-glyceraldehyde-3-phosphate-lyase"</pre>
reversible="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE_ASSOCIATION: (TTC0729 and TTC0730)
                 SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
                 EC Number: 4.2.1.20
                 Confidence Level: 1
                 AUTHORS: Amino acid metabolism
                 </body>
           </notes>
           distOfReactants>
              <speciesReference species="M_IND_GLYP_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
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<speciesReference species="M_GAP_c" stoichiometry="1"/>
    <speciesReference species="M IND c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R362" name="1-(2-Carboxyphenylamino)-1-deoxy-D-ribulose-5-phosphate carboxy-lyase(cyclizing)"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC0800
     SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
     EC Number: 4.1.1.48
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H_c" stoichiometry="1"/>
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<speciesReference species="M_CPhA_dRBL5P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_IND_GLYP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R363" name="N-(5-Phospho-beta-D-ribosyl)anthranilate ketol-isomerase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE ASSOCIATION: TTC1929
        SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
        EC Number: 5.3.1.24
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
```

```
</notes>
   listOfReactants>
    <speciesReference species="M_5PRIBS_ANTRL_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_CPhA_dRBL5P_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R364" name="N-(5-Phospho-D-ribosyl)anthranilate:pyrophosphate phosphoribosyl-transferase"</pre>
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1491
     SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
     EC Number: 2.4.2.18
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
```

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</body>
 </notes>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_5PRIBS_ANTRL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PRPP_c" stoichiometry="1"/>
 <speciesReference species="M_ANTHRL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R365" name="Chorismate pyruvatemutase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0020 or TTC0514)
  SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
  EC Number: 5.4.99.5
  Confidence Level: 1
```

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AUTHORS: Amino acid metabolism
                </body>
           </notes>
           listOfReactants>
             <speciesReference species="M_CORM_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_PPHA_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R366" name="Phosphoenolpyruvate:D-erythrose-4-phosphate C-(1-carboxyvinyl)transferase (phosphate</pre>
hydrolysing, 2-carboxy-2-oxoethyl-forming)" reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: (TTC0020 or TTC0448)
                SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
                EC Number: 2.5.1.54
```

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Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_PEP_c" stoichiometry="1"/>
 <speciesReference species="M_E4P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M Pi c" stoichiometry="1"/>
 <speciesReference species="M_DHYDO_ARAB_HEPTP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R367" name="cellobiose glucohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TT_P0042
         SUBSYSTEM: Alternate Carbon Metabolism
         EC Number: 3.2.1.21
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_CELBS_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_D_GLC_c" stoichiometry="2"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     defined and the control of t
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R368" name="ATP:alpha-D-glucose-1-phosphate adenylyltransferase" reversible="false">
   <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: (TTC1976 or TTC1977)
     SUBSYSTEM: Glycolysis/Gluconeogenesis
     EC Number: 2.7.7.27
     Confidence Level: 1
     AUTHORS: Carbohydrate metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M H c" stoichiometry="1"/>
  <speciesReference species="M_G1P_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_ADP_GLU_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R369" name="ADP-glucose:1,4-alpha-D-glucan 4-alpha-D-glucosyltransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1980
        SUBSYSTEM: Alternate Carbon Metabolism
        EC Number: 2.4.1.21
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_ADP_GLU_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M GLY c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R370" name="1,4-alpha-D-Glucan:orthophosphate alpha-D-glucosyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0808 and TTC1540 and TTC0897)
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 2.4.1.1
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_GLY_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_G1P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R371" name="maltose glucohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0107 or TTC1283 or TT_P0221)
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 3.2.1.20
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_MALT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GLC_c" stoichiometry="2"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R372" name="maltose glucohydrolase" reversible="false">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: (TTC0107 or TTC1283 or TT_P0221)
         SUBSYSTEM: Alternate Carbon Metabolism
         EC Number: 3.2.1.20
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_H2O_c" stoichiometry="1"/>
      <speciesReference species="M_IMALT_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_D_GLC_c" stoichiometry="2"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

```
<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R373" name="N-Acetyl-D-glucosamine-6-phosphate amidohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0025
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 3.5.1.25
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_AC_GLUSAP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
 <speciesReference species="M_GLUSAP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
```

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<parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R374" name="UTP:N-acetyl-alpha-D-glucosamine-1-phosphate uridylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0017
   SUBSYSTEM: Cell Envelope Biosynthesis
   EC Number: 2.7.7.23
   Confidence Level: 1
   AUTHORS: Lipid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_UTP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_AC_AGLUCSAPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_UDP_AGLUAM_c" stoichiometry="1"/>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

<listOfParameters>

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R375" name="Acetyl-CoA:D-glucosamine-1-phosphate N-acetyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0017
   SUBSYSTEM: Cell Envelope Biosynthesis
   EC Number: 2.3.1.157
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 <speciesReference species="M_GLUCSA1P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
```

```
<speciesReference species="M_AC_AGLUCSAPi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R376" name="UDP-N-acetyl-D-glucosamine 2-epimerase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0948
  SUBSYSTEM: Cell Envelope Biosynthesis
  EC Number: 5.1.3.14
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_UDP_AGLUAM_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_UDP_AC_MANNA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R377" name="D-Glucosamine 1-phosphate 1,6-phosphomutase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0691
  SUBSYSTEM: Cell Envelope Biosynthesis
  EC Number: 5.4.2.10
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GLUSAP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

```
<speciesReference species="M_GLUCSA1P_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R378" name="UDP-N-acetylmuramate:NADP+ oxidoreductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0721
        SUBSYSTEM: Cell Envelope Biosynthesis
        EC Number: 1.1.1.158
        Confidence Level: 1
        AUTHORS: Lipid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M NADPH c" stoichiometry="1"/>
     <speciesReference species="M_UDP_AC_CARBVIN_GLUCSA_c" stoichiometry="1"/>
```

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</listOfReactants>
   distOfProducts>
    <speciesReference species="M_UDP_ACMURM_c" stoichiometry="1"/>
    <speciesReference species="M_NADP_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R379" name="Phosphoenolpyruvate:UDP-N-acetyl-D-glucosamine 1-carboxyvinyl-transferase"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1854
     SUBSYSTEM: Cell Envelope Biosynthesis
     EC Number: 2.5.1.7
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
```

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listOfReactants>
 <speciesReference species="M UDP AGLUAM c" stoichiometry="1"/>
 <speciesReference species="M_PEP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_AC_CARBVIN_GLUCSA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R380" name="1D-myo-Inositol 4-phosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Inositol phosphate metabolism
   EC Number: 5.5.1.4
   Confidence Level: 1
   AUTHORS: Lipid metabolism
```

```
</body>
 </notes>
 <speciesReference species="M_G6P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_mINS3P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R381" name="1D-myo-Inositol 3-phosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1928
  SUBSYSTEM: Inositol phosphate metabolism
  EC Number: 3.1.3.25
  Confidence Level: 1
  AUTHORS: Lipid metabolism
```

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</body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_mINS3P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_M_INS_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R382" name="sn-Glycerol-3-phosphate:NAD+ 2-oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1378
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 1.1.1.94
   Confidence Level: 1
```

```
AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_DHAP_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_GLCP_c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R383" name="sn-Glycerol-3-phosphate:NADP+ 2-oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1378
```

```
SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 1.1.1.94
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_DHAP_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_GLCP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R384" name="acyl-CoA:sn-glycerol-3-phosphate 1-O-acyltransferase" reversible="false">
```

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<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: (TTC0841 or TTC1384)
 SUBSYSTEM: Glycerolipid metabolism
 EC Number: 2.3.1.15
 Confidence Level: 1
 AUTHORS: Lipid metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_GLCP_c" stoichiometry="1"/>
<speciesReference species="M_I150CoA_c" stoichiometry="0.334"/>
<speciesReference species="M_AI150CoA_c" stoichiometry="0.069"/>
<speciesReference species="M_I160CoA_c" stoichiometry="0.047"/>
<speciesReference species="M_C160CoA_c" stoichiometry="0.014"/>
<speciesReference species="M_C161CoA_c" stoichiometry="0.0015"/>
<speciesReference species="M_I170CoA_c" stoichiometry="0.45"/>
<speciesReference species="M Al171CoA c" stoichiometry="0.075"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_CoA_c" stoichiometry="1"/>
<speciesReference species="M_GLY3P_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
<listOfParameters>
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R385" name="acyl-CoA:1-acyl-sn-glycerol-3-phosphate 2-O-acyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0983
   SUBSYSTEM: Glycerolipid metabolism
   EC Number: 2.3.1.51
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_I150CoA_c" stoichiometry="0.334"/>
 <speciesReference species="M_AI150CoA_c" stoichiometry="0.069"/>
 <speciesReference species="M_I160CoA_c" stoichiometry="0.047"/>
 <speciesReference species="M_C160CoA_c" stoichiometry="0.014"/>
 <speciesReference species="M_C161CoA_c" stoichiometry="0.0015"/>
 <speciesReference species="M_I170CoA_c" stoichiometry="0.45"/>
 <speciesReference species="M_AI171CoA_c" stoichiometry="0.075"/>
 <speciesReference species="M_GLY3P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_CoA_c" stoichiometry="1"/>
    <speciesReference species="M PPTD c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R386" name="S-adenosyl-L-methionine:phosphatidylethanolamine N-methyltransferase"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1366
     SUBSYSTEM: Glycerophospholipid metabolism
     EC Number: 2.1.1.17
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_PETHA_c" stoichiometry="1"/>
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<speciesReference species="M_SAM_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_SAHC_c" stoichiometry="1"/>
     <speciesReference species="M_PMETHA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R387" name="phosphatidyl-N-methylethanolamine N-methyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Glycerophospholipid metabolism
        EC Number: 2.1.1.71
        Confidence Level: 1
        AUTHORS: Lipid metabolism
        </body>
   </notes>
```

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listOfReactants>
     <speciesReference species="M SAM c" stoichiometry="1"/>
     <speciesReference species="M_PMETHA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_SAHC_c" stoichiometry="1"/>
     <speciesReference species="M_PDMETHA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R388" name="phosphatidyl-N-dimethylethanolamine N-methyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Glycerophospholipid metabolism
        EC Number: 2.1.1.71
        Confidence Level: 1
        AUTHORS: Lipid metabolism
```

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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SAM_c" stoichiometry="1"/>
 <speciesReference species="M_PDMETHA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_SAHC_c" stoichiometry="1"/>
 <speciesReference species="M_PCHOL_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R389" name="Transacylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Glycerophospholipid metabolism
   EC Number: 
   Confidence Level: 1
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AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PETHA_c" stoichiometry="1"/>
 <speciesReference species="M_PCHOL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PX_c" stoichiometry="1"/>
 <speciesReference species="M_LYPCHOL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R390" name="acyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Glycerophospholipid metabolism
```

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EC Number: 
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
</notes>
distOfReactants>
  <\!speciesReference\ species="M_I150CoA\_c"\ stoichiometry="0.334"/\!>
  <speciesReference species="M_AI150CoA_c" stoichiometry="0.069"/>
  <speciesReference species="M_I160CoA_c" stoichiometry="0.047"/>
  <speciesReference species="M_C160CoA_c" stoichiometry="0.014"/>
  <speciesReference species="M C161CoA c" stoichiometry="0.0015"/>
  <speciesReference species="M_I170CoA_c" stoichiometry="0.45"/>
  <speciesReference species="M_AI171CoA_c" stoichiometry="0.075"/>
  <speciesReference species="M_LYPCHOL_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_CoA_c" stoichiometry="1"/>
  <speciesReference species="M PCHOL c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R391" name="phosphatidic acid phosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Glycerophospholipid metabolism
  EC Number: 
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_PPTD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_DAG_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R392" name="ATP:1,2-diacylglycerol 3-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0682
   SUBSYSTEM: Glycerolipid metabolism
   EC Number: 2.7.1.107
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_DAG_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_PPTD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R393" name="UDP-glucosyltransferase (diglucosyl)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Glycerolipid metabolism
   EC Number: 
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_UDP_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_DAG_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_MGDG_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R394" name="UDP-glucosyltransferase (monoglucosyl)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Glycerolipid metabolism
   EC Number: 
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_MGDG_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_GLU_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_DGDG_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R395" name="Phsophatidyl-L-serine carboxy-lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0815
  SUBSYSTEM: Glycerophospholipid metabolism
  EC Number: 4.1.1.65
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PPTD_SER_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PETHA_c" stoichiometry="1"/>
```

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<speciesReference species="M_CO2_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R396" name="CTP:phosphatidate cytidyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0505
  SUBSYSTEM: Glycerophospholipid metabolism
  EC Number: 2.7.7.41
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CTP_c" stoichiometry="1"/>
 <speciesReference species="M PPTD c" stoichiometry="1"/>
 </listOfReactants>
```

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listOfProducts>
     <speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M_CDP_DAG_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R397" name="CDPdiacy|glycerol:sn-glycerol-3-phosphate 3-phosphatidy|transferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Glycerophospholipid metabolism
        EC Number: 
        Confidence Level: 1
        AUTHORS: Lipid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_GLCP_c" stoichiometry="1"/>
```

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<speciesReference species="M_CDP_DAG_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CMP_c" stoichiometry="1"/>
 <speciesReference species="M_PGLYP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R398" name="Phosphatidylglycerophosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Glycerophospholipid metabolism
  EC Number: 3.1.3.27
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
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</notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_PGLYP_c" stoichiometry="1"/>
 </listOfReactants>
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 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R399" name="phosphatidylinositol phosphate synthase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Glycerophospholipid metabolism
   EC Number: 
   Confidence Level: 1
   AUTHORS: Lipid metabolism
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</body>
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 <speciesReference species="M_mINS3P_c" stoichiometry="1"/>
 <speciesReference species="M_CDP_DAG_c" stoichiometry="1"/>
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 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CMP_c" stoichiometry="1"/>
 <speciesReference species="M_PMINS3P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R400" name="1-phosphatidyl-1D-myo-inositol 3-phosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Glycerophospholipid metabolism
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EC Number: 3.1.3.64
         Confidence Level: 1
         AUTHORS: Lipid metabolism
         </body>
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     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_PMINS3P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PINS_c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R401" name="cardiolipin synthase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
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GENE_ASSOCIATION: 
  SUBSYSTEM: Glycerophospholipid metabolism
  EC Number: 
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PGLY_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CDLPN_c" stoichiometry="1"/>
 <speciesReference species="M_GLYCRL_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R402" name="Digalactosylceramide galactohydrolase" reversible="false">
 <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TT P0072
  SUBSYSTEM: Sphingolipid metabolism
  EC Number: 3.2.1.22
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
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 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_DGALSCRAMD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
 <speciesReference species="M_GALS_CA_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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<reaction id="R_R403" name="UDP-N-acetylmuramoyl-L-alanyl-D-glutamyl-L-lysine:alanyl-D-alanine ligase (ADP-forming)"</pre>
reversible="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE ASSOCIATION: TTC0714
                 SUBSYSTEM: Cell Envelope Biosynthesis
                 EC Number: 6.3.2.10
                 Confidence Level: 1
                 AUTHORS: Lipid metabolism
                 </body>
           </notes>
           distOfReactants>
              <speciesReference species="M_ATP_c" stoichiometry="1"/>
              <speciesReference species="M_D_ALA_D_ALA_c" stoichiometry="1"/>
              <speciesReference species="M_UDP_ACMUR_ALA_GLU_LYS_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M ADP c" stoichiometry="1"/>
              <speciesReference species="M_Pi_c" stoichiometry="1"/>
              <speciesReference species="M_UDP_MURAC_ALA_GLU_LYS_ALA_ALA_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                 <ci> FLUX_VALUE </ci>
              definition of the control of
                 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER\_BOUND" value="1000" units="mmol\_per\_gDW\_per\_hr" constant="true"/>

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R404" name="UDPMurAc(oyl-L-Ala-D-gamma-Glu-L-Lys-D-Ala-D-Ala):undecaprenyl-phosphate phospho-N-
acetylmuramoyl-pentapeptide-transferase" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC0716
     SUBSYSTEM: Cell Envelope Biosynthesis
     EC Number: 2.7.8.13
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_UDP_MURAC_ALA_GLU_LYS_ALA_ALA_c" stoichiometry="1"/>
    <speciesReference species="M_dt_pc_UNDECP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_UMP_c" stoichiometry="1"/>
    <speciesReference species="M_MURAC_ALA_GLU_LYS_ALA_ALA_DP_UNDECP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
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<parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
               <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
            </listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R_R405" name="UDP-N-acetylmuramoyl-L-alanyl-gamma-D-glutamyl-meso-2,6-diaminopimeloyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-alanyl-D-
alanine:undecaprenyl-phosphate phospho-N-acetylmuramoyl-pentapeptide-transferase" reversible="false">
          <notes>
            <body xmlns="http://www.w3.org/1999/xhtml">
               GENE_ASSOCIATION: TTC0716
               SUBSYSTEM: Cell Envelope Biosynthesis
               EC Number: 2.7.8.13
               Confidence Level: 1
               AUTHORS: Lipid metabolism
               </body>
          </notes>
          distOfReactants>
            <speciesReference species="M_UDP_ACMUR_ALA_GLU_DAPIM_ALA_ALA_c" stoichiometry="1"/>
            <speciesReference species="M_dt_pc_UNDECP_c" stoichiometry="1"/>
          </listOfReactants>
          distOfProducts>
            <speciesReference species="M UMP c" stoichiometry="1"/>
            <speciesReference species="M_Undp_ACMUR_ALA_GLU_DAPIM_AALA_c" stoichiometry="1"/>
          </listOfProducts>
          <kineticLaw>
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<listOfParameters>

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<math xmlns="http://www.w3.org/1998/Math/MathML">
               <ci> FLUX VALUE </ci>
            <listOfParameters>
               <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
            /listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R R406" name="UDP-N-acetyl-D-glucosamine:N-acetyl-alpha-D-muramyl(oyl-L-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-L-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Glu-Lys-D-Ala-gamma-D-Ala-gamma-D-Ala-gamma-D-Ala-gamma-D-Ala-gamma-D-Ala-gamma-D-Ala-gamma-D-Ala-
D-Ala)-diphosphoundecaprenol 4-beta-N-acetylglucosaminlytransferase" reversible="false">
          <notes>
            <body xmlns="http://www.w3.org/1999/xhtml">
               GENE_ASSOCIATION: TTC0719
               SUBSYSTEM: Cell Envelope Biosynthesis
               EC Number: 2.4.1.227
               Confidence Level: 1
               AUTHORS: Lipid metabolism
               </body>
          </notes>
          distOfReactants>
            <speciesReference species="M_UDP_AGLUAM_c" stoichiometry="1"/>
            <speciesReference species="M MURAC ALA GLU LYS ALA ALA DP UNDECP c" stoichiometry="1"/>
          </listOfReactants>
          distOfProducts>
            <speciesReference species="M_UDP_c" stoichiometry="1"/>
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<speciesReference species="M_Undp_ACMUR_ACGLSA_ALA_GLU_LYS_AALA_c" stoichiometry="1"/>
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   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R407" name="UDP-N-acetyl-D-glucosamine:undecaprenyl-diphospho-N-acetylmuramoyl-L-alanyl-gamma-
D-glutamyl-meso-2,6-diaminopimeloyl-D-alanyl-D-alanine 4-beta-N-acetylglucosaminlytransferase" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC0719
     SUBSYSTEM: Cell Envelope Biosynthesis
     EC Number: 2.4.1.227
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
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    <speciesReference species="M_Undp_ACMUR_ALA_GLU_DAPIM_AALA_c" stoichiometry="1"/>
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</listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_UDP_c" stoichiometry="1"/>
     <speciesReference species="M_Undp_ACMUR_ACGLSA_ALA_GLU_DAPIM_AALA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R408" name="undecaprenyl-diphosphate phosphohydrolase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1814
        SUBSYSTEM: Cell Envelope Biosynthesis
        EC Number: 3.6.1.27
        Confidence Level: 1
        AUTHORS: Lipid metabolism
        </body>
   </notes>
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listOfReactants>
 <speciesReference species="M H2O c" stoichiometry="1"/>
 <speciesReference species="M_dt_pc_UNDECPPi_c" stoichiometry="1"/>
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 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_dt_pc_UNDECP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R409" name="Lactoylglutathione lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0449
   SUBSYSTEM: Methylglyoxal Metabolism
   EC Number: 4.4.1.5
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
```

```
</body>
 </notes>
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 <speciesReference species="M_MGLX_c" stoichiometry="1"/>
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 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_LACGLUT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R410" name="hydroxyacylglutathione hydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0485
   SUBSYSTEM: Methylglyoxal Metabolism
   EC Number: 3.1.2.6
   Confidence Level: 1
```

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AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_LACGLUT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_LAC_c" stoichiometry="1"/>
 <speciesReference species="M GLUTAT c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R411" name="glycerone-phosphate phosphate-lyase (methylglyoxal-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1443
```

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SUBSYSTEM: Methylglyoxal Metabolism
   EC Number: 4.2.3.3
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_DHAP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M Pi c" stoichiometry="1"/>
 <speciesReference species="M_MGLX_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R412" name="ATP:pyruvate,phosphate phosphotransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

```
GENE_ASSOCIATION: TTC0304
 SUBSYSTEM: Pyruvate metabolism
 EC Number: 2.7.9.1
 Confidence Level: 1
 AUTHORS: Carbohydrate metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_ATP_c" stoichiometry="1"/>
<speciesReference species="M_Pi_c" stoichiometry="1"/>
<speciesReference species="M PYR c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_PPi_c" stoichiometry="1"/>
<speciesReference species="M_H_c" stoichiometry="1"/>
<speciesReference species="M_PEP_c" stoichiometry="1"/>
<speciesReference species="M_AMP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
distOfParameters>
 <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
</listOfParameters>
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</kineticLaw>
</reaction>
<reaction id="R_R413" name="ATP:pyruvate,water phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1136
   SUBSYSTEM: Glycolysis/Gluconeogenesis
   EC Number: 2.7.9.2
   Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_PEP_c" stoichiometry="1"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R414" name="(S)-lactate:oxygen 2-oxidoreductase (decarboxylating)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1744
   SUBSYSTEM: Pyruvate metabolism
   EC Number: 1.13.12.4
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_LAC_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R415" name="Acetyl phosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0199
   SUBSYSTEM: Pyruvate metabolism
   EC Number: 3.6.1.7
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_ACPi_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R416" name="acetyl adenylate:CoA acetyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0884 or TTC0885 or TTC0886 or TTC0919)
  SUBSYSTEM: Pyruvate metabolism
  EC Number: 6.2.1.1
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_ACADNA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M ACoA c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R417" name="ATP:acetate adenylyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC0884 or TTC0885 or TTC0886 or TTC0919)
   SUBSYSTEM: Pyruvate metabolism
   EC Number: 6.2.1.1
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_ACADNA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R418" name="(S)-malate:NAD+ oxidoreductase (decarboxylating)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0144
  SUBSYSTEM: Pyruvate metabolism
  EC Number: 1.1.1.38
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M MAL c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_PYR_c" stoichiometry="1"/>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R419" name="Glycolate oxidase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1940
        SUBSYSTEM: Pyruvate metabolism
        EC Number: 1.1.19.14
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
```

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</body>
           </notes>
           <speciesReference species="M_NAD_c" stoichiometry="1"/>
             <speciesReference species="M_HY_AC_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_H_c" stoichiometry="1"/>
             <speciesReference species="M_NADH_c" stoichiometry="1"/>
             <speciesReference species="M_GLOXT_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             </listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R420" name="acetyl-CoA:glyoxylate C-acetyltransferase (thioester-hydrolysing, carboxymethyl-forming)"</pre>
reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: TTC0130
                SUBSYSTEM: Pyruvate metabolism
```

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EC Number: 2.3.3.9
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 <speciesReference species="M_GLOXT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_MAL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R421" name="Formate:tetrahydrofolate ligase (ADP-forming)" reversible="true">
```

```
<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: TTC1707
 SUBSYSTEM: Folate Metabolism
 EC Number: 6.3.4.3
 Confidence Level: 1
 AUTHORS: Energy and cofactors metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_ATP_c" stoichiometry="1"/>
<speciesReference species="M_THF_c" stoichiometry="1"/>
<speciesReference species="M_FOR_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_ADP_c" stoichiometry="1"/>
<speciesReference species="M_Pi_c" stoichiometry="1"/>
<speciesReference species="M 10F THF c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
<listOfParameters>
 <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R422" name="10-Formyltetrahydrofolate amidohydrolase" reversible="false">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC0957
         SUBSYSTEM: Folate Metabolism
         EC Number: 3.5.1.10
         Confidence Level: 1
         AUTHORS: Energy and cofactors metabolism
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_H2O_c" stoichiometry="1"/>
      <speciesReference species="M_10F_THF_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_H_c" stoichiometry="1"/>
      <speciesReference species="M_THF_c" stoichiometry="1"/>
      <speciesReference species="M_FOR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R423" name="5,10-Methenyltetrahydrofolate 5-hydrolase (decyclizing)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0755
  SUBSYSTEM: Folate Metabolism
  EC Number: 3.5.4.9
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_10F_THF_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_METHF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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```
<parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R424" name="5,10-methylenetetrahydrofolate:NADP+ oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0755
   SUBSYSTEM: Folate Metabolism
   EC Number: 1.5.1.5
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_METHF_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

<listOfParameters>

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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R425" name="isocitrate glyoxylate-lyase (succinate-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1485
   SUBSYSTEM: Glyoxylate and dicarboxylate metabolism
   EC Number: 4.1.3.1
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ICIT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_SUCC_c" stoichiometry="1"/>
 <speciesReference species="M_GLOXT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R426" name="4-hydroxy-2-oxoglutarate glyoxylate-lyase (pyruvate-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0030
   SUBSYSTEM: Glyoxylate and dicarboxylate metabolism
   EC Number: 4.1.3.16
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_4HY_2OGLUTR_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M GLOXT c" stoichiometry="1"/>
 </listOfProducts>
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```
<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R427" name="Glycolate:oxygen 2-oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0129 or TTC0443)
  SUBSYSTEM: Glyoxylate and dicarboxylate metabolism
  EC Number: 1.1.3.15
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_HY_AC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_GLOXT_c" stoichiometry="1"/>
```

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<speciesReference species="M_H2O2_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R428" name="Glycolate:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0431
  SUBSYSTEM: Glyoxylate and dicarboxylate metabolism
  EC Number: 1.1.1.26
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M NADH c" stoichiometry="1"/>
 <speciesReference species="M_GLOXT_c" stoichiometry="1"/>
```

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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_HY_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R429" name="2-Phosphoglycolate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1471
  SUBSYSTEM: Glyoxylate and dicarboxylate metabolism
  EC Number: 3.1.3.18
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M 2P GLYCA c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_HY_AC_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R430" name="2-Hydroxybutyrate:NAD+ oxidoreductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0748
        SUBSYSTEM: Propanoate metabolism
        EC Number: 1.1.1.27
        Confidence Level: 1
        AUTHORS: Lipid metabolism
        </body>
```

```
</notes>
  listOfReactants>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_2HYBUTNA_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_AKB_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     /listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R431" name="Propionyladenylate:CoA propionyltransferase" reversible="true">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0884 or TTC0885 or TTC0886 or TTC0919)
        SUBSYSTEM: Propanoate metabolism
        EC Number: 6.2.1.1
        Confidence Level: 1
```

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AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_PROP_ADNSPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M_PRCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R432" name="ATP:propanoate adenylyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC0884 or TTC0885 or TTC0886 or TTC0919)
   SUBSYSTEM: Propanoate metabolism
```

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EC Number: 6.2.1.1
        Confidence Level: 1
        AUTHORS: Lipid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
     <speciesReference species="M_PROP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M_PROP_ADNSPi_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R433" name="pyruvate:pyruvate acetaldehydetransferase (decarboxylating)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: (TTC0851 and TTC0852)
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 2.2.1.6
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_S_ACLAC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 IistOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R434" name="glycine synthase" reversible="false">
```

```
<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: (TTC0150 and TTC0151)
 SUBSYSTEM: Folate Metabolism
 EC Number: 1.4.4.2
 Confidence Level: 1
 AUTHORS: Energy and cofactors metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_L_GLY_c" stoichiometry="1"/>
<speciesReference species="M_NAD_c" stoichiometry="1"/>
<speciesReference species="M_THF_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_H_c" stoichiometry="1"/>
<speciesReference species="M_NADH_c" stoichiometry="1"/>
<speciesReference species="M_CO2_c" stoichiometry="1"/>
<speciesReference species="M_NH4_c" stoichiometry="1"/>
<speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
/listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
listOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R435" name="adenosine nucleotides de novo biosynthesis " reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Folate Metabolism
   EC Number: 
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M FMN c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_dATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_FMNH2_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R436" name="5-Formyltetrahydrofolate cyclo-ligase (ADP-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC1247 or TTC1803)
   SUBSYSTEM: Folate Metabolism
   EC Number: 6.3.3.2
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_FOLNA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_METHF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R437" name="5-methyltetrahydrofolate:NADP+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1656
  SUBSYSTEM: Folate Metabolism
  EC Number: 1.5.1.20
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
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```
<speciesReference species="M_5MTHF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R438" name="5-methyltetrahydrofolate:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1656
  SUBSYSTEM: Folate Metabolism
  EC Number: 1.5.1.20
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M NADH c" stoichiometry="1"/>
 <speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
```

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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_5MTHF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R439" name="L-cysteine:[Thil] sulfurtransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0087 or TTC1373)
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 2.8.1.7
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
```

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<speciesReference species="M_L_CYS_c" stoichiometry="1"/>
     <speciesReference species="M ENZ CYS c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_L_ALA_c" stoichiometry="1"/>
     <speciesReference species="M_ENZ_SLUFA_CYS_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R440" name="ATP:4-amino-2-methyl-5-phosphomethylpyrimidine phosphotransferase" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0321
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.7.4.7
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
```

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</notes>
   distOfReactants>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_4A_M5PM_PYRM_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_ADP_c" stoichiometry="1"/>
    <speciesReference species="M_2M4A_HYMPYRMPPi_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R441" name="ATP:4-amino-5-hydroxymethyl-2-methylpyrimidine 5-phosphotransferase"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC0321
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 2.7.1.49
     Confidence Level: 1
```

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AUTHORS: Energy and cofactors metabolism
      </body>
    </notes>
    listOfReactants>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_TOPYRM_c" stoichiometry="1"/>
    </listOfReactants>
    distOfProducts>
    <speciesReference species="M_ADP_c" stoichiometry="1"/>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M 4A M5PM PYRM c" stoichiometry="1"/>
    </listOfProducts>
    <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
      <ci> FLUX_VALUE </ci>
    <listOfParameters>
      <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
      <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
    </kineticLaw>
  </reaction>
  <reaction id="R_R442" name="2-methyl-4-amino-5-hydroxymethylpyrimidine-diphosphate:4-methyl-5-(2-phosphoethyl)-
thiazole 2-methyl-4-aminopyridine-5-methenyltransferase" reversible="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC0315
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 2.5.1.3
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_2M4A_HYMPYRMPPi_c" stoichiometry="1"/>
 <speciesReference species="M 4M PE THZ c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_TMP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

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<reaction id="R_R443" name="ATP:thiamin-phosphate phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0056
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.4.16
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_TMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_TPP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R444" name="Thiamin diphosphate phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 3.6.1.6
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_TPP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_TMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R445" name="Glycine oxidase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0318
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_H2O2_c" stoichiometry="1"/>
 <speciesReference species="M_IMAC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
```

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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R446" name="Thiazole synthase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0317
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.8.1.10
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_CYS_c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_IMAC_c" stoichiometry="1"/>
 <speciesReference species="M_dXYLL5P_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_L_ALA_c" stoichiometry="1"/>
 <speciesReference species="M PPi c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="2"/>
```

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<speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M THZ c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R447" name="Thiazole isomerase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 5.3.99.10
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M THZ c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
    <speciesReference species="M 4M PE THZ c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R448" name="D-ribulose 5-phosphate formate-lyase (L-3,4-dihydroxybutan-2-one 4-phosphate-forming)"
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0697
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 4.1.99.12
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_RBL5P_c" stoichiometry="1"/>
```

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</listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_FOR_c" stoichiometry="1"/>
     <speciesReference species="M_DHY_BUTNPi_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R449" name="GTP 7,8-8,9-dihydrolase (diphosphate-forming)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0697
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 3.5.4.25
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
```

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listOfReactants>
    <speciesReference species="M GTP c" stoichiometry="1"/>
    <speciesReference species="M_H2O_c" stoichiometry="3"/>
    </listOfReactants>
    distOfProducts>
    <speciesReference species="M_PPi_c" stoichiometry="1"/>
    <speciesReference species="M_H_c" stoichiometry="2"/>
    <speciesReference species="M_FOR_c" stoichiometry="1"/>
    <speciesReference species="M_DA_PRIBSA_PYMDN_c" stoichiometry="1"/>
    </listOfProducts>
    <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
      <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
    </kineticLaw>
  </reaction>
  <reaction id="R R450" name="5-amino-6-(5-phosphoribitylamino)uracil:NADP+ 1&apos;-oxidoreductase"</pre>
reversible="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      GENE_ASSOCIATION: TTC0699
      SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
      EC Number: 1.1.1.193
```

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Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADPH_c" stoichiometry="1"/>
     <speciesReference species="M_AP_RIB_URA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M NADP c" stoichiometry="1"/>
     <speciesReference species="M_APRIBTA_URA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R451" name="ATP:riboflavin 5&apos;-phosphotransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC0159
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.1.26
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_RBFLV_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_FMN_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

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<reaction id="R_R452" name="ATP:FMN adenylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0159
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.7.2
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_FMN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M FAD c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R453" name="riboflavin-5-phosphate phosphohydrolase (acid optimum)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1252
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 3.1.3.2
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_FMN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_RBFLV_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R454" name="Nicotinate-nucleotide:dimethylbenzimidazole phospho-D-ribosyltransferase"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TT P0005
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 2.4.2.21
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M NC D RNUC c" stoichiometry="1"/>
    <speciesReference species="M_CBMCo_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M_NIA_c" stoichiometry="1"/>
    <speciesReference species="M_PRIBS_DMBENZ_IMDZ_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
```

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distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R455" name="2,5-Diamino-6-hydroxy-4-(5-phosphoribosylamino)-pyrimidine 2-aminohydrolase"
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0699
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 3.5.4.26
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M_DA_PRIBSA_PYMDN_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_NH4_c" stoichiometry="1"/>
    <speciesReference species="M_AP_RIB_URA_c" stoichiometry="1"/>
```

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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R456" name="5-amino-6-(D-ribitylamino)uracil butanedionetransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1647
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.5.1.78
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_DHY_BUTNPi_c" stoichiometry="1"/>
 <speciesReference species="M_5AM_RIBAM_URA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M H2O c" stoichiometry="2"/>
     <speciesReference species="M_DM_DR_LUM_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R457" name="O-Phospho-4-hydroxy-L-threonine phospho-lyase (adding water)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0117
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 4.2.3.1
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
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<speciesReference species="M_OPHY_THR_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_HY_THR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R458" name="Nicotinate D-ribonucleotide:diphosphate phosphoribosyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0252
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.4.2.11
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
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listOfReactants>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_PRPP_c" stoichiometry="1"/>
 <speciesReference species="M_NIA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_NC_D_RNUC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R459" name="N-Ribosylnicotinamide:orthophosphate ribosyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0194 or TTC1070)
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.4.2.1
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_RIBS_NCTA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_R1P_c" stoichiometry="1"/>
     <speciesReference species="M_NAMD_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R460" name="Nicotinate D-ribonucleoside:orthophosphate ribosyltransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0194 or TTC1070)
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.4.2.1
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Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_NICRIB_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M R1P c" stoichiometry="1"/>
 <speciesReference species="M_NIA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R461" name="Nicotinamide ribonucleotide phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 3.1.3.5
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
</notes>
listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NMN_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_RIBS_NCTA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
</kineticLaw>
</reaction>
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<reaction id="R_R462" name="Nicotinate-nucleotide:pyrophosphate phosphoribosyltransferase (carboxylating)"
reversible="false">
```

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<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
      GENE_ASSOCIATION: TTC0621
      SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
      EC Number: 2.4.2.19
      Confidence Level: 1
      AUTHORS: Energy and cofactors metabolism
      </body>
</notes>
listOfReactants>
  <speciesReference species="M_H_c" stoichiometry="2"/>
  <speciesReference species="M_PRPP_c" stoichiometry="1"/>
  <speciesReference species="M_QA_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_CO2_c" stoichiometry="1"/>
  <speciesReference species="M_NC_D_RNUC_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
      <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R463" name="ATP:nicotinamide-nucleotide adenylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1421
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.7.18
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_NMN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R464" name="deamido-NAD+:ammonia ligase (AMP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1538
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.1.5
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 <speciesReference species="M_DA_NAD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M NAD c" stoichiometry="1"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R465" name="NADPH:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1778 and (TTC1779 or TTC1780))
  SUBSYSTEM: Oxidative Phosphorylation
  EC Number: 1.6.1.1 and 1.6.1.2
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M NADP c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
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   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R466" name="L-aspartate:oxygen oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0619
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.4.3.16
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_H2O2_c" stoichiometry="1"/>
 <speciesReference species="M_IMASP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R467" name="glycerone phosphate:iminosuccinate alkyltransferase (cyclizing)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0620
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.5.1.72
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
```

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listOfReactants>
 <speciesReference species="M DHAP c" stoichiometry="1"/>
 <speciesReference species="M_IMASP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="2"/>
 <speciesReference species="M_QA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R468" name="Nicotinate D-ribonucleotide phosphohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0964 or TTC1625 or TT_P0028)
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 3.1.3.5
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
```

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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_NC_D_RNUC_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_NICRIB_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     defined and the control of t
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R469" name="ATP:nicotinamide-nucleotide adenylyltransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1421
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.7.7.18
```

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Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NC_D_RNUC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M PPi c" stoichiometry="1"/>
 <speciesReference species="M_DA_NAD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R470" name="6-Carboxyhyxanoate:CoA ligase (AMP-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC1711
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 6.2.1.14
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_CoA_c" stoichiometry="1"/>
  <speciesReference species="M PIM c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_AMP_c" stoichiometry="1"/>
  <speciesReference species="M_PIMCoA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R471" name="dethiobiotin:sulfur sulfurtransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC0242
         SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
         EC Number: 2.8.1.6
         Confidence Level: 1
         AUTHORS: Energy and cofactors metabolism
         </body>
   </notes>
   <speciesReference species="M_SAM_c" stoichiometry="2"/>
     <speciesReference species="M_DTBTN_c" stoichiometry="1"/>
     <speciesReference species="M_S_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_L_MET_c" stoichiometry="2"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_BTN_c" stoichiometry="1"/>
     <speciesReference species="M_dADNS_c" stoichiometry="2"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R472" name="biotin:CoA ligase (AMP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1761
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.4.15
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_BTN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_BTN_AMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R473" name="BiotinyI-5&apos;-AMP:apo-[carboxylase] ligase (AMP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1761
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.4.15
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_BTN_AMP_c" stoichiometry="1"/>
 <speciesReference species="M_APCARB_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M_HCARB_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R474" name="octanoyl-[acp]:sulfur sulfurtransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1747
   SUBSYSTEM: Lipoic acid metabolism 
   EC Number: 2.8.1.8
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SAM_c" stoichiometry="2"/>
 <speciesReference species="M_S_c" stoichiometry="2"/>
 <speciesReference species="M_OCT_ACP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_MET_c" stoichiometry="2"/>
 <speciesReference species="M_dADNS_c" stoichiometry="2"/>
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<speciesReference species="M_LP_ACP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R475" name="protein N6-(octanoyl)lysine:sulfur sulfurtransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1747
   SUBSYSTEM: Lipoic acid metabolism 
   EC Number: 2.8.1.8
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SAM_c" stoichiometry="2"/>
 <speciesReference species="M_S_c" stoichiometry="2"/>
 <speciesReference species="M_PN6_OCTLYS_c" stoichiometry="1"/>
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</listOfReactants>
   distOfProducts>
     <speciesReference species="M_L_MET_c" stoichiometry="2"/>
     <speciesReference species="M_dADNS_c" stoichiometry="2"/>
     <speciesReference species="M_PN6_LPLYS_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R476" name="octanoyl-[acp]:protein N6-octanoyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1746
        SUBSYSTEM: Lipoic acid metabolism 
        EC Number: 2.3.1.181
        Confidence Level: 1
        AUTHORS: Lipid metabolism
        </body>
   </notes>
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listOfReactants>
     <speciesReference species="M OCT ACP c" stoichiometry="1"/>
     <speciesReference species="M_APPRO_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_PN6_OCTLYS_c" stoichiometry="1"/>
     <speciesReference species="M_ACP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R477" name="lipoyl-[acp]:protein N6-lipoyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1746
        SUBSYSTEM: Lipoic acid metabolism 
        EC Number: 2.3.1.181
        Confidence Level: 1
        AUTHORS: Lipid metabolism
```

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</body>
 </notes>
 distOfReactants>
 <speciesReference species="M_LP_ACP_c" stoichiometry="1"/>
 <speciesReference species="M_APPRO_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PN6_LPLYS_c" stoichiometry="1"/>
 <speciesReference species="M_ACP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R478" name="2,3-Dihydroxy-3-methylbutanoate:NADP+ oxidoreductase (isomerizing)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0850
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.1.1.86
   Confidence Level: 1
```

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AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_S_ACLAC_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M DHY MBUTNA c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R479" name="2,3-Dihydroxy-3-methylbutanoate hydro-lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0871
```

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SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 4.2.1.9
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_DHY_MBUTNA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_2K3M_BUT_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R480" name="5,10-Methylenetetrahydrofolate:3-methyl-2-oxobutanoate hydroxymethyltransferase"</pre>
reversible="false">
   <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC0039
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 2.1.2.11
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M 5 10 MNTHF c" stoichiometry="1"/>
  <speciesReference species="M_2K3M_BUT_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_THF_c" stoichiometry="1"/>
  <speciesReference species="M_DHY_PAN_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
</kineticLaw>
```

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</reaction>
<reaction id="R R481" name="ATP:pantothenate 4&apos;-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1008
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.1.33
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_PANTO_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_PPANT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R482" name="(R)-4&apos;-Phosphopantothenate:L-cysteine ligase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1195
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.2.5
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_CYS_c" stoichiometry="1"/>
 <speciesReference species="M_CTP_c" stoichiometry="1"/>
 <speciesReference species="M PPANT c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CMP_c" stoichiometry="1"/>
 <speciesReference species="M_PPANTN_CYS_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R483" name="N-[(R)-4&apos;-Phosphopantothenoyl]-L-cysteine carboxy-lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1195
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 4.1.1.36
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_PPANTN_CYS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_PANTE4Pi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R484" name="ATP:pantetheine-4&apos;-phosphate adenylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0560
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.7.3
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_PANTE4Pi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
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<speciesReference species="M_DPCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R485" name="ATP:dephospho-CoA 3&apos;-phosphotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0557
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.1.24
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M DPCoA c" stoichiometry="1"/>
 </listOfReactants>
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listOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R486" name="GTP 8,9-hydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1517
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 3.5.4.16
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_GTP_c" stoichiometry="1"/>
     <speciesReference species="M H2O c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_FAPYRM_NTP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R487" name="formamidopyrimidine nucleoside triphosphate amidohydrolase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1517
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 3.5.4.16
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
```

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listOfReactants>
     <speciesReference species="M H2O c" stoichiometry="1"/>
     <speciesReference species="M_FAPYRM_NTP_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_FOR_c" stoichiometry="1"/>
     <speciesReference species="M_DAPYRM_NTP_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R488" name="2,5-Diaminopyrimidine nucleoside triphosphate mutase" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1517
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 3.5.4.16
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
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</body>
   </notes>
   <speciesReference species="M_DAPYRM_NTP_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_DA_TPiTHY_OPENTAOPYRM_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R489" name="2-Amino-4-hydroxy-6-(erythro-1,2,3-trihydroxypropyl) dihydropteridine triphosphate
hydrolase" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1517
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 3.5.4.16
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
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</body>
           </notes>
           listOfReactants>
             <speciesReference species="M_DA_TPiTHY_OPENTAOPYRM_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M_AHYRY_THYPROP_DHYPTRN_TPi_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R490" name="2-Amino-4-hydroxy-6-(erythro-1,2,3-trihydroxypropyl) dihydropteridine triphosphate
phosphohydrolase (alkaline optimum)" reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: TT_P0024
                SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
                EC Number: 3.1.3.1
```

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Confidence Level: 1
                AUTHORS: Energy and cofactors metabolism
                </body>
           </notes>
           listOfReactants>
             <speciesReference species="M_H2O_c" stoichiometry="3"/>
             <speciesReference species="M_AHYRY_THYPROP_DHYPTRN_TPi_c" stoichiometry="1"/>
           </listOfReactants>
           listOfProducts>
             <speciesReference species="M_Pi_c" stoichiometry="3"/>
             <speciesReference species="M H c" stoichiometry="2"/>
             <speciesReference species="M_DHY_NPTRN_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R491" name="2-amino-4-hydroxy-6-(D-erythro-1,2,3-trihydroxypropyl)-7,8-dihydropteridine
glycolaldehyde-lyase" reversible="false">
           <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC1796
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 4.1.2.25
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_DHY_NPTRN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GLYCALD_c" stoichiometry="1"/>
 <speciesReference species="M_AHY_HYM_DHYPTR_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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<reaction id="R_R492" name="ATP:2-amino-4-hydroxy-6-hydroxymethyl-7,8-dihydropteridine 6&apos;-</p>
pyrophosphotransferase" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1387
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 2.7.6.3
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_AHY_HYM_DHYPTR_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M_AMP_c" stoichiometry="1"/>
    <speciesReference species="M_ADHY_DPOM_PTRDN_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER\_BOUND" value="1000" units="mmol\_per\_gDW\_per\_hr" constant="true"/>

<parameter id="FLUX\_VALUE" value="0" units="mmol\_per\_gDW\_per\_hr" constant="true"/>

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              /listOfParameters>
            </kineticLaw>
        </reaction>
        <reaction id="R_R493" name="2-amino-4-hydroxy-6-hydroxymethyl-7,8-dihydropteridine-diphosphate:4-aminobenzoate 2-
amino-4-hydroxydihydropteridine-6-methenyltransferase" reversible="false">
            <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                  GENE_ASSOCIATION: TTC1795
                  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
                  EC Number: 2.5.1.15
                  Confidence Level: 1
                  AUTHORS: Energy and cofactors metabolism
                  </body>
            </notes>
            listOfReactants>
              <speciesReference species="M_ADHY_DPOM_PTRDN_c" stoichiometry="1"/>
              <speciesReference species="M_ABEE_c" stoichiometry="1"/>
            </listOfReactants>
            distOfProducts>
              <speciesReference species="M_PPi_c" stoichiometry="1"/>
              <speciesReference species="M_DHY_PTR_c" stoichiometry="1"/>
            </listOfProducts>
            <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                 <ci> FLUX_VALUE </ci>
              definition of the control of
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
               <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
            /listOfParameters>
          </kineticLaw>
        </reaction>
       <reaction id="R_R494" name="2-amino-4-hydroxy-6-hydroxymethyl-7,8-dihydropteridine:4-aminobenzoate 2-amino-4-hydroxymethyl-7,8-dihydropteridine:4-aminobenzoate 2-amino-4-aminobenzoate 2-amino-4-aminobenzoate 2-aminobenzoate 2-am
hydroxydihydropteridine-6-methenyltransferase" reversible="false">
          <notes>
            <body xmlns="http://www.w3.org/1999/xhtml">
               GENE_ASSOCIATION: TTC1795
               SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
               EC Number: 2.5.1.15
               Confidence Level: 1
               AUTHORS: Energy and cofactors metabolism
               </body>
          </notes>
          distOfReactants>
            <speciesReference species="M_AHY_HYM_DHYPTR_c" stoichiometry="1"/>
            <speciesReference species="M_ABEE_c" stoichiometry="1"/>
          </listOfReactants>
          distOfProducts>
            <speciesReference species="M_H2O_c" stoichiometry="1"/>
            <speciesReference species="M DHY PTR c" stoichiometry="1"/>
          </listOfProducts>
          <kineticLaw>
            <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R495" name="Tetrahydrofolate:L-glutamate gamma-ligase (ADP-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: (TTC0975 or TTC1640)
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.2.17
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_THF_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
```

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<speciesReference species="M_THF_GLUT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R496" name="7,8-dihydropteroate:L-glutamate ligase (ADP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0975 or TTC1640)
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.2.17
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M ATP c" stoichiometry="1"/>
 <speciesReference species="M_DHY_PTR_c" stoichiometry="1"/>
```

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</listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_DHF_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R497" name="1-Deoxy-D-xylulose-5-phosphate pyruvate-lyase (carboxylating)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1614
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.2.1.7
        Confidence Level: 1
        AUTHORS: Carotenoid metabolism
        </body>
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</notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GAP_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_dXYLL5P_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R498" name="1-Deoxy-D-xylulose-5-phosphate isomeroreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0504
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.1.1.267
   Confidence Level: 1
```

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AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_dXYLL5P_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M MEROLPi c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R499" name="CTP: 2-C-Methyl-D-erythritol 4-phosphate cytidylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1815
```

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SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 2.7.7.60
  Confidence Level: 1
  AUTHORS: Carotenoid metabolism
  </body>
</notes>
listOfReactants>
 <speciesReference species="M_CTP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_MEROLPi_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_CYTPPi_MEROL_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
</kineticLaw>
</reaction>
```

```
<reaction id="R_R500" name="ATP:4-(Cytidine 5&apos;-diphospho)-2-C-methyl-D-erythritol 2-phosphotransferase"</pre>
reversible="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  GENE_ASSOCIATION: TTC1816
                  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
                  EC Number: 2.7.1.148
                  Confidence Level: 1
                  AUTHORS: Carotenoid metabolism
                  </body>
            </notes>
            distOfReactants>
               <speciesReference species="M_ATP_c" stoichiometry="1"/>
               <speciesReference species="M_CYTPPi_MEROL_c" stoichiometry="1"/>
            </listOfReactants>
            distOfProducts>
               <speciesReference species="M_ADP_c" stoichiometry="1"/>
               <speciesReference species="M H c" stoichiometry="1"/>
               <speciesReference species="M_PCYTPPi_MEROL_c" stoichiometry="1"/>
            </listOfProducts>
            <kineticLaw>
               <math xmlns="http://www.w3.org/1998/Math/MathML">
                  <ci> FLUX_VALUE </ci>
               definition of the control of
                  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER\_BOUND" value="1000" units="mmol\_per\_gDW\_per\_hr" constant="true"/>

<parameter id="FLUX\_VALUE" value="0" units="mmol\_per\_gDW\_per\_hr" constant="true"/>

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R501" name="2-Phospho-4-(cytidine 5&apos;-diphospho)-2-C-methyl-D-erythritol CMP-lyase (cyclizing)"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1438
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 4.6.1.12
     Confidence Level: 1
     AUTHORS: Carotenoid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_PCYTPPi_MEROL_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
    <speciesReference species="M_CMP_c" stoichiometry="1"/>
    <speciesReference species="M_MEROL_CYCPPi_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R502" name="(E)-4-hydroxy-3-methylbut-2-en-1-yl-diphosphate:oxidized ferredoxin oxidoreductase
(hydrating)" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1677
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 1.17.7.1
     Confidence Level: 1
     AUTHORS: Carotenoid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M_MEROL_CYCPPi_c" stoichiometry="1"/>
    <speciesReference species="M_R_FRDX_c" stoichiometry="2"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M HY MBUTEPPi c" stoichiometry="1"/>
    <speciesReference species="M_O_FRDX_c" stoichiometry="2"/>
   </listOfProducts>
   <kineticLaw>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R503" name="isopentenyl-diphosphate:NAD(P)+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1983
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.17.1.2
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_HY_MBUTEPPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
```

```
<speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M IPEN PPi c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R504" name="dimethyallyl diphosphate:NADP+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1983
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.17.1.2
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
```

```
<speciesReference species="M_HY_MBUTEPPi_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_NADP_c" stoichiometry="1"/>
     <speciesReference species="M_DMAPP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R505" name="isopentenyl-diphosphate:NAD+ oxidoreductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1983
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 1.17.1.2
        Confidence Level: 1
        AUTHORS: Carotenoid metabolism
        </body>
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</notes>
  distOfReactants>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_HY_MBUTEPPi_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_IPEN_PPi_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R506" name="dimethyallyl diphosphate:NAD+ oxidoreductase" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1983
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 1.17.1.2
```

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Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_HY_MBUTEPPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_DMAPP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R507" name="Z-farnesyl diphosphate synthase" reversible="false">
 <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC1551
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 2.5.1.68
  Confidence Level: 1
  AUTHORS: Carotenoid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_IPEN_PPi_c" stoichiometry="1"/>
 <speciesReference species="M GRN PPi c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_ct_FARPPi_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

```
<reaction id="R_R508" name="Dimethylallyl-diphosphate:isopentenyl-diphosphate dimethylallyltranstransferase"
reversible="false">
```

```
<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE ASSOCIATION: TTC1986
 SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
 EC Number: 2.5.1.1
 Confidence Level: 1
 AUTHORS: Carotenoid metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_IPEN_PPi_c" stoichiometry="1"/>
<speciesReference species="M_DMAPP_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_PPi_c" stoichiometry="1"/>
<speciesReference species="M GRN PPi c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
<listOfParameters>
 <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R509" name="Isopentenyl-diphosphate delta3-delta2-isomerase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TT_P0067 or TTC0228)
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 5.3.3.2
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_IPEN_PPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M DMAPP c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R510" name="Geranyl-diphosphate:isopentenyl-diphosphate geranyltrans-transferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1986
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.5.1.10
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_IPEN_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_GRN_PPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_FAR_PPi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R511" name="trans,trans-Farnesyl-diphosphate:isopentenyl-diphosphate farnesyltranstransferase"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC1986
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 2.5.1.29
     Confidence Level: 1
     AUTHORS: Carotenoid metabolism
     </body>
   </notes>
   <speciesReference species="M_IPEN_PPi_c" stoichiometry="1"/>
    <speciesReference species="M_FAR_PPi_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_PPi_c" stoichiometry="1"/>
    <speciesReference species="M_GRN_GRNPPi_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
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<parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R512" name="carvone reductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Limonene and pinene degradation
   EC Number: 1.3.99.25
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
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 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_IDHY_CRVN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
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listOfParameters>

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distOfParameters>
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                 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
              </listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R513" name="geranylgeranyl-diphosphate:geranylgeranyl-diphosphate geranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylgeranylg
reversible="false">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE_ASSOCIATION: TT_P0057
                 SUBSYSTEM: Carotenoid biosynthesis
                 EC Number: 2.5.1.32
                 Confidence Level: 1
                 AUTHORS: Carotenoid metabolism
                 </body>
           </notes>
           listOfReactants>
              <speciesReference species="M_GRN_GRNPPi_c" stoichiometry="2"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M PPi c" stoichiometry="2"/>
              <speciesReference species="M_PHTEN_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
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   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R514" name="15-cis-phytoene:plastoquinone oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TT_P0047 or TT_P0066)
   SUBSYSTEM: Carotenoid biosynthesis
   EC Number: 1.3.5.5
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
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 <speciesReference species="M_FAD_c" stoichiometry="1"/>
 <speciesReference species="M_PHTEN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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 <speciesReference species="M_PHFLN_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
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  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R515" name="15-cis-phytoene:acceptor oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0066
  SUBSYSTEM: Carotenoid biosynthesis
  EC Number: 1.3.99.28
  Confidence Level: 1
  AUTHORS: Carotenoid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_FAD_c" stoichiometry="1"/>
 <speciesReference species="M_PHFLN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_FADH2_c" stoichiometry="1"/>
 <speciesReference species="M zCARO c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R516" name="Neurosporene, hydrogen-donor:oxygen oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TT P0066
  SUBSYSTEM: Carotenoid biosynthesis
  EC Number: 1.3.99.28
  Confidence Level: 1
  AUTHORS: Carotenoid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_FADH2_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
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<speciesReference species="M_NRSPENE_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="2"/>
 <speciesReference species="M_FAD_c" stoichiometry="1"/>
 <speciesReference species="M_LCPN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R517" name="zeta-Carotene, hydrogen-donor:oxygen oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0066
   SUBSYSTEM: Carotenoid biosynthesis
   EC Number: 1.3.99.28
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
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</notes>
 distOfReactants>
 <speciesReference species="M_FADH2_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_zCARO_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="2"/>
 <speciesReference species="M_FAD_c" stoichiometry="1"/>
 <speciesReference species="M_NRSPENE_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R518" name="ethylnitronate:oxygen 2-oxidoreductase (nitrite-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1901
   SUBSYSTEM: Nitrogen metabolism
   EC Number: 1.13.12.16
```

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Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_FMNH2_c" stoichiometry="1"/>
 <speciesReference species="M_ENITRN_c" stoichiometry="1"/>
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 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_AALD_c" stoichiometry="1"/>
 <speciesReference species="M_FMN_c" stoichiometry="1"/>
 <speciesReference species="M_NO2_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R519" name="Ammonia:ferredoxin oxidoreductase" reversible="true">
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<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0313
     SUBSYSTEM: Nitrogen metabolism
     EC Number: 1.7.7.1
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_H_c" stoichiometry="7"/>
  <speciesReference species="M_R_FRDX_c" stoichiometry="6"/>
  <speciesReference species="M_NO2_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_H2O_c" stoichiometry="2"/>
  <speciesReference species="M_NH4_c" stoichiometry="1"/>
  <speciesReference species="M O FRDX c" stoichiometry="6"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R520" name="L-Glutamine amidohydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1104 or TTC0282 or (TTC0247 or TTC1706))
   SUBSYSTEM: Glutamate Metabolism
   EC Number: 1.4.1.13 or 6.3.5.4 or 6.3.5.5
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R521" name="L-aspartate:L-glutamine amido-ligase (AMP-forming)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0282
   SUBSYSTEM: Alanine and Aspartate Metabolism
   EC Number: 6.3.5.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
 <speciesReference species="M L GLN c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_L_ASN_c" stoichiometry="1"/>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
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 <speciesReference species="M AMP c" stoichiometry="1"/>
 </listOfProducts>
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<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R522" name="Sulfite:ferricytochrome-c oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1046 or TTC1650)
   SUBSYSTEM: Sulfur metabolism 
   EC Number: 1.8.2.1
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_CYT_C3_c" stoichiometry="2"/>
 <speciesReference species="M_SO3_c" stoichiometry="1"/>
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 distOfProducts>
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<speciesReference species="M SO4 c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R523" name="adenosine 3&apos;,5&apos;-bisphosphate,sulfite:oxidized-thioredoxin oxidoreductase
(3'-phosphoadenosine-5'-phosphosulfate -forming)" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC0310 or TTC0961)
     SUBSYSTEM: Sulfur metabolism 
     EC Number: 1.8.4.8
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_R_TRED_c" stoichiometry="1"/>
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<speciesReference species="M\_CYT\_C2\_c" stoichiometry="2"/>

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<speciesReference species="M_PAPS_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_O_TRED_c" stoichiometry="1"/>
     <speciesReference species="M_SO3_c" stoichiometry="1"/>
     <speciesReference species="M_PAP_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R524" name="Cystathionine L-homocysteine-lyase (deaminating)" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1256
        SUBSYSTEM: Sulfur metabolism 
        EC Number: 4.4.1.8
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
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</body>
           </notes>
           <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M_CYSTHN_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
             <speciesReference species="M_PYR_c" stoichiometry="1"/>
             <speciesReference species="M_NH4_c" stoichiometry="1"/>
             <speciesReference species="M_L_HCYS_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             </listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R525" name="5,10-methylenetetrahydromethanopterin:glycine hydroxymethyltransferase"</pre>
reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: TTC1160
                SUBSYSTEM: Methane metabolism
```

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EC Number: 2.1.2.1
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 <speciesReference species="M_H4MPT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_METHMPTR_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R526" name="(R)-2-phospho-3-sulfolactate phosphohydrolase" reversible="true">
 <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC1073
  SUBSYSTEM: Methane metabolism
  EC Number: 3.1.3.71
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_PSULFLAC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_SULFLAC_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

```
<reaction id="R_R527" name="Uroporphyrinogen I carboxy-lyase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0232
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 4.1.1.37
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_UPPHYRGN_I_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_H_c" stoichiometry="4"/>
     <speciesReference species="M_CO2_c" stoichiometry="4"/>
     <speciesReference species="M_CPPHYRGN_I_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     </listOfParameters>
```

```
</kineticLaw>
</reaction>
<reaction id="R_R528" name="Uroporphyrinogen-III carboxy-lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0232
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 4.1.1.37
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="4"/>
 <speciesReference species="M_UPPHYRGN_III_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="4"/>
 <speciesReference species="M_CPPPHYRGN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R529" name="5-aminolevulinate hydro-lyase (adding 5-aminolevulinate and cyclizing" reversible="false">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC1234
         SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
         EC Number: 4.2.1.24
         Confidence Level: 1
         AUTHORS: Energy and cofactors metabolism
         </body>
   </notes>
   distOfReactants>
      <speciesReference species="M_ALEVU_c" stoichiometry="2"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_H2O_c" stoichiometry="2"/>
      <speciesReference species="M_H_c" stoichiometry="1"/>
      <speciesReference species="M_PPBLGN_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R530" name="porphobilinogen:(4-[2-carboxyethyl]-3-[carboxymethyl]pyrrol-2-yl)methyltransferase</pre>
(hydrolysing)" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1638
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 2.5.1.61
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_PPBLGN_c" stoichiometry="4"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_NH4_c" stoichiometry="4"/>
    <speciesReference species="M_HY_MBILN_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
```

<parameter id="UPPER\_BOUND" value="1000" units="mmol\_per\_gDW\_per\_hr" constant="true"/>

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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R531" name="Hydroxymethylbilane hydro-lyase(cyclizing)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0312 or TTC1143)
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 4.2.1.75
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_HY_MBILN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_UPPHYRGN_III_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

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<ci> FLUX_VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R R532" name="coproporphyrinogen-III:S-adenosyl-L-methionine oxidoreductase(decarboxylating)"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0123
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 1.3.99.22
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   <speciesReference species="M_SAM_c" stoichiometry="2"/>
    <speciesReference species="M_CPPPHYRGN_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_L_MET_c" stoichiometry="2"/>
    <speciesReference species="M_CO2_c" stoichiometry="2"/>
```

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<speciesReference species="M_dADNS_c" stoichiometry="2"/>
 <speciesReference species="M PPPHYRGN c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R533" name="protoporphyrinogen-IX:oxygen oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0230
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.3.3.4
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_O2_c" stoichiometry="3"/>
 <speciesReference species="M_PPPHYRGN_c" stoichiometry="1"/>
```

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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O2_c" stoichiometry="3"/>
 <speciesReference species="M_PPPHYR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R534" name="protoheme ferro-lyase (protoporphyrin-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0231
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 4.99.1.1
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_PPPHYR_c" stoichiometry="1"/>
     <speciesReference species="M Fe2 c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_HEME_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R535" name="(S)-4-Amino-5-oxopentanoate 4,5-aminomutase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0564
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 5.4.3.8
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
```

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</notes>
   listOfReactants>
     <speciesReference species="M_GLU_SA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ALEVU_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R536" name="S-adenosyl-L-methionine:uroporphyrin-III C-methyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0308 or TT_P0017)
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.1.1.107
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
```

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</notes>
   listOfReactants>
     <speciesReference species="M_SAM_c" stoichiometry="2"/>
     <speciesReference species="M_UPPHYRGN_III_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_SAHC_c" stoichiometry="2"/>
     <speciesReference species="M_PRCRN_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R537" name="Magnesium-protoporphyrin IX chelatase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0268
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 6.6.1.1
        Confidence Level: 1
```

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AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M_PPPHYR_c" stoichiometry="1"/>
  <speciesReference species="M_Mg_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
  <speciesReference species="M_ADP_c" stoichiometry="1"/>
  <speciesReference species="M_Pi_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="3"/>
  <speciesReference species="M_Mg_PPPHYR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
  distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R538" name="protoheme IX farnesyltransferase" reversible="false">
```

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<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: 
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 2.5.1.-
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
</notes>
distOfReactants>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M_FAR_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_HEME_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_HEMO_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
  </listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R539" name="S-Adenosyl-L-methionine:uroporphyrin-III C-methyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0311
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 4.99.1.4
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_Fe2_c" stoichiometry="1"/>
 <speciesReference species="M_SRHYCLR_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M H c" stoichiometry="3"/>
 <speciesReference species="M_SHEME_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R540" name="S-Adenosyl-L-methionine:uroporphyrin-III C-methyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0311
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.3.1.76
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_PRCRN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_SRHYCLR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R541" name="S-adenosyl-L-methionine:precorrin-4 C20-methyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0011
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.1.1.130
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_SAM_c" stoichiometry="1"/>
 <speciesReference species="M_PRCRN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_SAHC_c" stoichiometry="1"/>
 <speciesReference species="M_PRCRN3A_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R542" name="S-adenosyl-L-methionine:cobalt-factor-II C20-methyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0011
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.1.1.151
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SAM_c" stoichiometry="1"/>
 <speciesReference species="M_CoSRHYCLR_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_SAHC_c" stoichiometry="1"/>
 <speciesReference species="M CoFIII c" stoichiometry="1"/>
 </listOfProducts>
```

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<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R543" name="precorrin-3B C17-methyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0013
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.1.1.131
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_SAM_c" stoichiometry="1"/>
 <speciesReference species="M_CoPRCRN3_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_SAHC_c" stoichiometry="1"/>
 <speciesReference species="M CoPRCRN4 c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R544" name="S-adenosyl-L-methionine:precorrin-3B C17-methyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TT P0013
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.1.1.131
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M SAM c" stoichiometry="1"/>
 <speciesReference species="M_PRCRN3B_c" stoichiometry="1"/>
```

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</listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_SAHC_c" stoichiometry="1"/>
     <speciesReference species="M_PRCRN4_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R545" name="S-adenosyl-L-methionine:precorrin-4 C11 methyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TT_P0012
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.1.1.133
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
```

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listOfReactants>
 <speciesReference species="M SAM c" stoichiometry="1"/>
 <speciesReference species="M_PRCRN4_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_SAHC_c" stoichiometry="1"/>
 <speciesReference species="M_PRCRN5_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R546" name="cobalt-precorrin-4 methyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0012
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.1.1.133
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
```

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</body>
    </notes>
    listOfReactants>
    <speciesReference species="M_SAM_c" stoichiometry="1"/>
    <speciesReference species="M_CoPRCRN4_c" stoichiometry="1"/>
    </listOfReactants>
    distOfProducts>
    <speciesReference species="M_SAHC_c" stoichiometry="1"/>
    <speciesReference species="M_CoPRCRN5A_c" stoichiometry="1"/>
    </listOfProducts>
    <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
    listOfParameters>
      <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
      <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
    </kineticLaw>
  </reaction>
  <reaction id="R_R547" name="S-Adenosyl-L-methionine:1-precorrin-6Y C5,15-methyltransferase (C-12-decarboxylating)"</pre>
reversible="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      GENE_ASSOCIATION: TT_P0010
      SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
```

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EC Number: 2.1.1.132
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_SAM_c" stoichiometry="2"/>
 <speciesReference species="M_PRCRN6B_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M H c" stoichiometry="2"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_SAHC_c" stoichiometry="2"/>
 <speciesReference species="M_PRCRN8X_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R548" name="precorrin-8X methylmutase" reversible="false">
```

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<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0009
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 5.4.1.2
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PRCRN8X_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_HOBYRNA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R549" name="precorrin-8X methylmutase" reversible="false">
```

```
<notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TT_P0009
         SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
         EC Number: 5.4.1.2
         Confidence Level: 1
         AUTHORS: Energy and cofactors metabolism
         </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_CoPRCRN8_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_CBRYNA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R550" name="cobyrinic acid A,C-diamide synthase" reversible="false">
```

```
<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TT_P0001
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 6.3.5.9
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_L_GLN_c" stoichiometry="2"/>
  <speciesReference species="M_ATP_c" stoichiometry="2"/>
  <speciesReference species="M_H2O_c" stoichiometry="2"/>
  <speciesReference species="M_HOBYRNA_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_L_GLU_c" stoichiometry="2"/>
  <speciesReference species="M ADP c" stoichiometry="2"/>
  <speciesReference species="M_Pi_c" stoichiometry="2"/>
  <speciesReference species="M_H_c" stoichiometry="2"/>
  <speciesReference species="M_HOBYRNDA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R551" name="cobyrinate:L-glutamine amido-ligase (ADP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0001
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.5.11
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M L GLN c" stoichiometry="2"/>
 <speciesReference species="M_ATP_c" stoichiometry="2"/>
 <speciesReference species="M_H2O_c" stoichiometry="2"/>
 <speciesReference species="M_CBRYNA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="2"/>
 <speciesReference species="M_ADP_c" stoichiometry="2"/>
 <speciesReference species="M_Pi_c" stoichiometry="2"/>
 <speciesReference species="M H c" stoichiometry="3"/>
 <speciesReference species="M_Co2ABYRDA_c" stoichiometry="1"/>
```

```
</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R552" name="adenosylcobyric acid synthase (glutamine-hydrolysing)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0023
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.5.10
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLN_c" stoichiometry="4"/>
 <speciesReference species="M_ATP_c" stoichiometry="4"/>
 <speciesReference species="M H2O c" stoichiometry="4"/>
 <speciesReference species="M_ADNS_CABYRDA_c" stoichiometry="1"/>
```

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</listOfReactants>
   distOfProducts>
     <speciesReference species="M_L_GLU_c" stoichiometry="4"/>
     <speciesReference species="M_ADP_c" stoichiometry="4"/>
     <speciesReference species="M_Pi_c" stoichiometry="4"/>
     <speciesReference species="M_H_c" stoichiometry="4"/>
     <speciesReference species="M_ADNS_CABYRHA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R553" name="Cobalt synthesis" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 6.6.1.2
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
```

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</body>
 </notes>
 listOfReactants>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M_HOBYRNDA_c" stoichiometry="1"/>
  <speciesReference species="M_CO_LPAREN_II_RPAREN__c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
  <speciesReference species="M_ADP_c" stoichiometry="1"/>
  <speciesReference species="M_Pi_c" stoichiometry="1"/>
  <speciesReference species="M H c" stoichiometry="3"/>
  <speciesReference species="M_Co2ABYRDA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
  distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R554" name="ATP:cob(I)yrinic acid-a,c-diamide Cobeta-adenosyltransferase" reversible="false">
 <notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TT_P0002
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.5.1.17
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_CABYRDA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_TPi_c" stoichiometry="1"/>
 <speciesReference species="M_ADNS_CABYRDA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R555" name="ATP:cobinamide Cobeta-adenosyltransferase" reversible="true">
```

```
<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: TT_P0002
 SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
 EC Number: 2.5.1.17
 Confidence Level: 1
 AUTHORS: Energy and cofactors metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_ATP_c" stoichiometry="1"/>
<speciesReference species="M_H_c" stoichiometry="1"/>
<speciesReference species="M_CBAMD_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_TPi_c" stoichiometry="1"/>
<speciesReference species="M_ADNS_CBNA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
distOfParameters>
 <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
</listOfParameters>
```

```
</kineticLaw>
</reaction>
<reaction id="R_R556" name="adenosylcobyric acid:(R)-1-aminopropan-2-yl phosphate ligase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0019
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.1.10
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_ADNS_CABYRHA_c" stoichiometry="1"/>
 <speciesReference species="M_APRNPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_ADNS_CBNAPi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R557" name="cobalamin [5&apos;-phosphate] synthase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0004
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.8.26
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M ADNS CBNA GDP c" stoichiometry="1"/>
 <speciesReference species="M_ARIBZ_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GMP_c" stoichiometry="1"/>
 <speciesReference species="M_CBMCo_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R558" name="citrullinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 3.5.1.20
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CTRLN_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_ORT_c" stoichiometry="1"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
```

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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R559" name="malate dehydrogenase (quinone)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Citric Acid Cycle
  EC Number: 1.1.5.4
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_MAL_c" stoichiometry="1"/>
 <speciesReference species="M_Q_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_OAC_c" stoichiometry="1"/>
 <speciesReference species="M QH2 c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R560" name="prephenate dehydratase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: 
  EC Number: 4.2.1.51
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_PPHA_c" stoichiometry="1"/>
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</listOfReactants>
          distOfProducts>
             <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M_CO2_c" stoichiometry="1"/>
             <speciesReference species="M_PPYR_c" stoichiometry="1"/>
          </listOfProducts>
          <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R R561" name="3-isopropylmalate dehydrogenase; beta-isopropylmalic enzyme; beta-isopropylmalate
dehydrogenase; threo-Ds-3-isopropylmalate dehydrogenase; 3-carboxy-2-hydroxy-4-methylpentanoate:NAD+ oxidoreductase"
reversible="false">
          <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: TTC0867
                SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
                EC Number: 1.1.1.85
                Confidence Level: 1
                AUTHORS: Amino acid metabolism
                </body>
```

```
</notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_IPROP_OSUCC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_4M_2OPENTN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R562" name="prephenate dehydrogenase (NADP+)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0447
   SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
   EC Number: 1.3.1.13
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
```

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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_PPHA_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M HYPh PYR c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R563" name="N2-acetyl-alpha-aminoadipate semialdehyde transaminase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1393
```

```
SUBSYSTEM: Threonine and Lysine Metabolism
        EC Number: 2.6.1.-
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
     <speciesReference species="M_AC_AADP_SA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_AKG_c" stoichiometry="1"/>
     <speciesReference species="M_N2AC_L_LYS_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R564" name="alpha-aminoadipate acetyltransferase" reversible="true">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC1543
     SUBSYSTEM: Threonine and Lysine Metabolism
     EC Number: 6.3.2.-
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
distOfReactants>
  <speciesReference species="M_ACoA_c" stoichiometry="1"/>
  <speciesReference species="M AADP c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_CoA_c" stoichiometry="1"/>
  <speciesReference species="M_AC_AADP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R565" name="methanogen homoaconitase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC1546 and TTC1547)
  SUBSYSTEM: Threonine and Lysine Metabolism
  EC Number: 4.2.1.114
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_HCIT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_HICTR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
```

```
</kineticLaw>
</reaction>
<reaction id="R_R566" name="CDP-diacylglycerol-serine O-phosphatidyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0824
   SUBSYSTEM: Membrane Lipid Metabolism
   EC Number: 2.7.8.8
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 <speciesReference species="M_CDP_DAG_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_CMP_c" stoichiometry="1"/>
 <speciesReference species="M_PPTD_SER_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R567" name="sulfite reductase (NADPH2)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0961
   SUBSYSTEM: Cysteine and methionine metabolism
   EC Number: 1.8.2.2
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="5"/>
 <speciesReference species="M NADPH c" stoichiometry="3"/>
 <speciesReference species="M_SO3_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="3"/>
 <speciesReference species="M_NADP_c" stoichiometry="3"/>
 <speciesReference species="M_H2S_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R568" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Inorganic Ion Transport and Metabolism
   EC Number: 
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_O2_c" stoichiometry="2"/>
 <speciesReference species="M_H2S_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_SO4_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R569" name="catalase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC1872
         SUBSYSTEM: Unassigned
         EC Number: 
         Confidence Level: 1
         AUTHORS: Energy and cofactors metabolism
         </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O2_c" stoichiometry="2"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="2"/>
     <speciesReference species="M_O2_c" stoichiometry="1"/>
   </listOfProducts>
```

```
<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R570" name="cytochrome c oxidase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0769 and TTC0770 and TTC1671 and TTC1672)
   SUBSYSTEM: Oxidative Phosphorylation
   EC Number: 1.9.3.1
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="6"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_CYT_C2_c" stoichiometry="4"/>
 </listOfReactants>
 distOfProducts>
```

```
<speciesReference species="M_H2O_c" stoichiometry="2"/>
     <speciesReference species="M H e" stoichiometry="6"/>
     <speciesReference species="M_CYT_C3_c" stoichiometry="4"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R571" name="trehalase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0614
        SUBSYSTEM: Alternate Carbon Metabolism
        EC Number: 3.2.1.28
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
```

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<speciesReference species="M_TRE_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GLC_c" stoichiometry="2"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R572" name="trehalose-6-phosphate hydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0107
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 3.2.1.93
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
```

```
<speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M TRE6P c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GLC_c" stoichiometry="1"/>
 <speciesReference species="M_G6P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R573" name="trehalose-6-phosphate phosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 3.1.3.12
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
```

```
</notes>
   listOfReactants>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_TRE6P_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_Pi_c" stoichiometry="1"/>
    <speciesReference species="M_TRE_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R574" name="ATP synthase" reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC0905 and TTC0906 and TTC0907 and TTC0908 and TTC0909 and TTC0910 and TTC0911 and
TTC0912)
     SUBSYSTEM: Oxidative Phosphorylation
     EC Number: 3.6.3.14
     Confidence Level: 1
```

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AUTHORS: Energy and cofactors metabolism
      </body>
    </notes>
    listOfReactants>
    <speciesReference species="M_ADP_c" stoichiometry="1"/>
    <speciesReference species="M_Pi_c" stoichiometry="1"/>
    <speciesReference species="M_H_e" stoichiometry="4"/>
    </listOfReactants>
    listOfProducts>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M H2O c" stoichiometry="1"/>
    <speciesReference species="M_H_c" stoichiometry="3"/>
    </listOfProducts>
    <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
      <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
    </kineticLaw>
  </reaction>
  <reaction id="R_R575" name="2-methylpropanoyl-CoA:enzyme N6-(dihydrolipoyl)lysine S-(2-methylpropanoyl)transferase"
reversible="false">
    <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TTC1757
  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
  EC Number: 2.3.1.168
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M DHYLPL MPROP MPROP DHLPL c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_2M_PROCoA_c" stoichiometry="1"/>
 <speciesReference species="M_ENZNE_DHYLPL_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

```
<reaction id="R_R576" name="(S)-2-methylbutanoyl-CoA:enzyme N6-(dihydrolipoyl)lysine S-(2-methylbutanoyl)transferase" reversible="false">
```

```
<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE ASSOCIATION: TTC1757
 SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
 EC Number: 2.3.1.168
 Confidence Level: 1
 AUTHORS: Amino acid metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_CoA_c" stoichiometry="1"/>
<speciesReference species="M_DHYLPL_MPROP_2MBUT_DHLPL_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
<speciesReference species="M_MBUTNCoA_c" stoichiometry="1"/>
<speciesReference species="M ENZNE DHYLPL c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
<listOfParameters>
 <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
            </kineticLaw>
         </reaction>
         <reaction id="R_R577" name="3-methylbutanoyl-CoA:enzyme N6-(dihydrolipoyl)lysine S-(3-methylbutanoyl)transferase"</pre>
reversible="false">
            <notes>
               <body xmlns="http://www.w3.org/1999/xhtml">
                  GENE ASSOCIATION: TTC1757
                  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
                  EC Number: 2.3.1.168
                  Confidence Level: 1
                  AUTHORS: Amino acid metabolism
                  </body>
            </notes>
            listOfReactants>
               <speciesReference species="M_CoA_c" stoichiometry="1"/>
               <speciesReference species="M_DHYLPL_MPROP_3MBUT_DHLPL_c" stoichiometry="1"/>
            </listOfReactants>
            distOfProducts>
               <speciesReference species="M_ENZNE_DHYLPL_c" stoichiometry="1"/>
               <speciesReference species="M_IVCoA_c" stoichiometry="1"/>
            </listOfProducts>
            <kineticLaw>
               <math xmlns="http://www.w3.org/1998/Math/MathML">
                  <ci> FLUX VALUE </ci>
               definition of the control of
                  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R578" name="dihydrolipoyl dehydrogenase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1700 or TTC1753)
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.8.1.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M NAD c" stoichiometry="1"/>
 <speciesReference species="M_ENZNE_DHYLPL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_ENZN6_LPL_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
```

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distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R579" name="3-methylbutanoyl-CoA:electron-transfer flavoprotein 2,3-oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0238 or TTC0536 or TTC779 or TTC1552 or TTC1575 or TT_P0074)
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.3.8.7
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_FAD_c" stoichiometry="1"/>
 <speciesReference species="M_IVCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_FADH2_c" stoichiometry="1"/>
 <speciesReference species="M_MCROCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R580" name="3-Methylcrotonoyl-CoA:carbon-dioxide ligase (ADP-forming)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1192
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 6.4.1.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_HCO3_c" stoichiometry="1"/>
 <speciesReference species="M_MCROCoA_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
```

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<speciesReference species="M_Pi_c" stoichiometry="1"/>
    <speciesReference species="M 3MGLUTNCoA c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
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     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R581" name="(S)-3-Hydroxy-3-methylglutaryl-CoA hydro-lyase (trans-3-methylglutaconyl-CoA-forming)"</pre>
reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC0182
     SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
     EC Number: 4.2.1.18
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
```

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<speciesReference species="M_3MGLUTNCoA_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_HYM_GLUTRCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R582" name="succinyl-CoA:acetoacetate CoA-transferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Citric Acid Cycle
  EC Number: 2.8.3.5
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_SUCCoA_c" stoichiometry="1"/>
 <speciesReference species="M AAC c" stoichiometry="1"/>
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 distOfProducts>
 <speciesReference species="M_SUCC_c" stoichiometry="1"/>
 <speciesReference species="M_ACACoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R583" name="(S)-3-Hydroxyisobutyryl-CoA hydrolase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 3.1.2.4
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
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</notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_HYIBUTRCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_HYIBUTRA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R584" name="(2S,3S)-3-hydroxy-2-methylbutanoyl-CoA:NAD+ oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0534
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 1.1.1.35
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
```

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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_HY_MBUTRCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_MAACCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R585" name="Methylmalonyl-CoA epimerase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0024
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
```

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EC Number: 5.1.99.1
                Confidence Level: 1
                AUTHORS: Amino acid metabolism
                </body>
           </notes>
           listOfReactants>
             <speciesReference species="M_R_MMALCoA_c" stoichiometry="1"/>
           </listOfReactants>
           listOfProducts>
             <speciesReference species="M_MMALCoA_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
                <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R586" name="biotin carboxyl carrier protein of acetyl-CoA carboxylase, acetyl-CoA carboxylase
carboxyltransferase subunit alpha, acetyl-coenzyme A carboxylase carboxyl transferase subunit beta" reversible="false">
           <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                GENE_ASSOCIATION: (TTC1408 and TTC1409)
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```
SUBSYSTEM: Membrane Lipid Metabolism
     EC Number: 6.4.1.2
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_ACoA_c" stoichiometry="1"/>
  <speciesReference species="M_HCO3_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_ADP_c" stoichiometry="1"/>
  <speciesReference species="M_Pi_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_MALCoA_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
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</reaction>
<reaction id="R R587" name="phosphoribosylglycinamide formyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0459
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.1.2.2
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 <speciesReference species="M_GAR_c" stoichiometry="1"/>
 <speciesReference species="M_10F_THF_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M FGAR c" stoichiometry="1"/>
 <speciesReference species="M_THF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R588" name="fumarate reductase (menaquinone)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1089
  SUBSYSTEM: Citric Acid Cycle
  EC Number: 1.3.5.4
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_FUM_c" stoichiometry="1"/>
 <speciesReference species="M_MQL_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_SUCC_c" stoichiometry="1"/>
 <speciesReference species="M_MQ_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R589" name="succinate dehydrogenase membrane anchor subunit" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1092
   SUBSYSTEM: Oxidative Phosphorylation
   EC Number: 1.3.5.1
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SUCC_c" stoichiometry="1"/>
 <speciesReference species="M_Q_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_FUM_c" stoichiometry="1"/>
 <speciesReference species="M_QH2_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R590" name="formate C-acetyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Pyruvate Metabolism
   EC Number: 2.3.1.54
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 <speciesReference species="M_FOR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
```

```
<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R591" name="protoporphyrinogen IX dehydrogenase (menaquinone)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.3.5.3
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_MQ_c" stoichiometry="3"/>
 <speciesReference species="M_PPPHYRGN_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_PPPHYR_c" stoichiometry="1"/>
 <speciesReference species="M MQL c" stoichiometry="3"/>
 </listOfProducts>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R592" name="L-glutamate 5-semialdehyde dehydratase (spontaneous)" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Arginine and Proline Metabolism
  EC Number: spontaneous
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_GLUT_SA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
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<kineticLaw>

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<speciesReference species="M_PYRR5CARB_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R593" name="serine O-acetyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1875
   SUBSYSTEM: Cysteine and methionine metabolism
   EC Number: 2.3.1.30
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 <speciesReference species="M ACoA c" stoichiometry="1"/>
 </listOfReactants>
```

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<speciesReference species="M CoA c" stoichiometry="1"/>
     <speciesReference species="M_OAC_SER_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R594" name="pyruvate dehydrogenase E1 component beta subunit" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0568 and TTC1801 and TTC1802 and TTC1754 and TTC1753 and TTC1700)
        SUBSYSTEM: Glycolysis/Gluconeogenesis
        EC Number: 1.2.1.-
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
```

distOfProducts>

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<speciesReference species="M_PYR_c" stoichiometry="1"/>
     <speciesReference species="M CoA c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_ACoA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R595" name="acetaldehyde dehydrogenase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0604
        SUBSYSTEM: Pyruvate Metabolism
        EC Number: 1.2.1.10
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
```

```
</body>
 </notes>
 distOfReactants>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_AALD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R596" name="pyrimidine phosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
```

```
EC Number: 3.6.1.-
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_APRIBTA_URA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M Pi c" stoichiometry="1"/>
     <speciesReference species="M_5AM_RIBAM_URA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R597" name="riboflavin synthase subunit alpha" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
```

```
GENE_ASSOCIATION: TTC0698
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 2.5.1.9
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_DM_DR_LUM_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_RBFLV_c" stoichiometry="1"/>
 <speciesReference species="M_5AM_RIBAM_URA_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R598" name="NADPH quinone reductase" reversible="false">
 <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE ASSOCIATION: 
 SUBSYSTEM: Oxidative Phosphorylation
 EC Number: 1.6.5.10
 Confidence Level: 1
 AUTHORS: Energy and cofactors metabolism
 </body>
</notes>
distOfReactants>
<speciesReference species="M_H_c" stoichiometry="1"/>
<speciesReference species="M NADPH c" stoichiometry="1"/>
<speciesReference species="M_Q_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_NADP_c" stoichiometry="1"/>
<speciesReference species="M_QH2_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
IistOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
</listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R599" name="NADPH quinone reductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Oxidative Phosphorylation
  EC Number: 1.6.5.10
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_MQ_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M NADP c" stoichiometry="1"/>
 <speciesReference species="M_MQL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R600" name="2-dehydropantoate 2-reductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.1.1.169
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M DHY PAN c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_PANTA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R601" name="adenine phosphoribosyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC1249 or TTC1250)
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.4.2.7
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PRPP_c" stoichiometry="1"/>
 <speciesReference species="M_ADN_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
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distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R602" name="cobalamin [5&apos;-phosphate] synthase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0004 
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.7.8.26
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_PRIBS_DMBENZ_IMDZ_c" stoichiometry="1"/>
 <speciesReference species="M_ADNS_CBNA_GDP_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_GMP_c" stoichiometry="1"/>
 <speciesReference species="M CBMCo c" stoichiometry="1"/>
 </listOfProducts>
```

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R603" name="GMP synthase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0355 or TTC1187)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 6.3.5.2
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_XMP_c" stoichiometry="1"/>
 </listOfReactants>
```

<kineticLaw>

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distOfProducts>
 <speciesReference species="M L GLU c" stoichiometry="1"/>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M_GMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R604" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
```

```
</notes>
 listOfReactants>
  <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M_XMP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
  <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
  <speciesReference species="M_L_ASN_c" stoichiometry="1"/>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M H c" stoichiometry="1"/>
  <speciesReference species="M_AMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
  distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R605" name="GTP cyclohydrolase I" reversible="false">
 <notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
```

```
GENE_ASSOCIATION: TTC1517
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.5.4.16
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GTP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_FOR_c" stoichiometry="1"/>
 <speciesReference species="M_AHYRY_THYPROP_DHYPTRN_TPi_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

```
<reaction id="R_R606" name="mannose-1-phosphate guanylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1388
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 2.7.7.13
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GTP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_MAN1P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M GDP MAN c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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/listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R607" name="GTPase" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
          GENE_ASSOCIATION: TTC1158
          SUBSYSTEM: Nucleotide Salvage Pathway
          EC Number: 3.6.5.-
         Confidence Level: 1
          AUTHORS: Nucleotides metabolism
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_GTP_c" stoichiometry="1"/>
      <speciesReference species="M_H2O_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_Pi_c" stoichiometry="1"/>
      <speciesReference species="M_H_c" stoichiometry="1"/>
      <speciesReference species="M_GDP_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
          <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R608" name="phosphoribosylaminoimidazole carboxylase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0137 and TTC0138)
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 4.1.1.21
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_AIR_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_CAIR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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```
<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R609" name="adenosylcobinamide-phosphate synthase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TT P0019
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 6.3.1.10
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_ADNS_CABYRHA_c" stoichiometry="1"/>
 <speciesReference species="M_A_PROPOL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_ADNS_CBNAPi_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R610" name="2-keto-3-deoxy-gluconate kinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0036
  SUBSYSTEM: Alternate Carbon Metabolism
  EC Number: 2.7.1.45
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_2K3DO_GLCN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
```

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<speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M H c" stoichiometry="1"/>
     <speciesReference species="M_DHY_DOP_GLUCN_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     defined and the control of t
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R611" name="2-phosphoglycerate kinase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0121
        SUBSYSTEM: Glycine and Serine Metabolism
        EC Number: 2.7.1.165
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
```

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<speciesReference species="M_D_GLCT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_2PG_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R612" name="Propionate-CoA ligase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0884
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 6.2.1.17
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
```

```
</notes>
  listOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
     <speciesReference species="M_CoA_c" stoichiometry="1"/>
     <speciesReference species="M_PROP_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_PPi_c" stoichiometry="1"/>
     <speciesReference species="M_AMP_c" stoichiometry="1"/>
     <speciesReference species="M_PRCoA_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R613" name="NH(3)-dependent NAD(+) synthetase" reversible="false">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1538
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 6.3.5.1
```

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Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
  <speciesReference species="M_ATP_c" stoichiometry="1"/>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M_DA_NAD_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
  <speciesReference species="M_PPi_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_NAD_c" stoichiometry="1"/>
  <speciesReference species="M_AMP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

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</reaction>
<reaction id="R R614" name="NAD+ kinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 2.7.1.23
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M H c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R615" name="acid phosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1252
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 3.1.3.2
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 </listOfReactants>
 ducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R616" name="thymidine kinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 2.7.1.21
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_THYMD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_dTMP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
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distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R617" name="adenylyl-sulfate kinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0307
  SUBSYSTEM: Cysteine and methionine metabolism
  EC Number: 2.7.1.25
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_APS_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M PAPS c" stoichiometry="1"/>
 </listOfProducts>
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<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R618" name="urea carboxylase/allophanate hydrolase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC0624
   SUBSYSTEM: Arginine and Proline Metabolism
   EC Number: 6.3.4.6
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M UREA c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_UREA_CARB_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     defined and the control of t
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R619" name="carbamate kinase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Unassigned
        EC Number: 2.7.2.2
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
```

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<speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CARB_Pi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R620" name="acetate kinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0137
  SUBSYSTEM: Pyruvate Metabolism
  EC Number: 2.7.2.1
  Confidence Level: 1
```

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AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_ACPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R621" name="phosphoenolpyruvate carboxylase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0260
   SUBSYSTEM: Glycolysis/Gluconeogenesis
```

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EC Number: 4.1.1.31
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_PEP_c" stoichiometry="1"/>
     <speciesReference species="M_HCO3_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M Pi c" stoichiometry="1"/>
     <speciesReference species="M_OAC_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R622" name="dihydroorotate dehydrogenase (quinone)" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC0616
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 1.3.5.2
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_Q_c" stoichiometry="1"/>
 <speciesReference species="M_DHY_ORTA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_QH2_c" stoichiometry="1"/>
 <speciesReference species="M_ORTA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R623" name="NAD+ diphosphatase" reversible="false">
```

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<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: TTC0964
 SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
 EC Number: 3.6.1.22
 Confidence Level: 1
 AUTHORS: Energy and cofactors metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_H2O_c" stoichiometry="1"/>
<speciesReference species="M_NAD_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
<speciesReference species="M_H_c" stoichiometry="2"/>
<speciesReference species="M_AMP_c" stoichiometry="1"/>
<speciesReference species="M_NMN_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
distOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
/listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R624" name="NMN nucleosidase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 3.2.2.14
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NMN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_R5P_c" stoichiometry="1"/>
 <speciesReference species="M_NAMD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R625" name="nicotinamidase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1446
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 3.5.1.19
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAMD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 <speciesReference species="M_NIA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R626" name="nicotinamide-nucleotide amidase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1468
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 3.5.1.42
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NMN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 <speciesReference species="M_NC_D_RNUC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R627" name="nicotinate-nucleotide adenylyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1421
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.7.18
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NC_D_RNUC_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_DA_NAD_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R628" name="NAD+ nucleosidase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 3.2.2.5
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M ADP RIB c" stoichiometry="1"/>
     <speciesReference species="M_NAMD_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R629" name="thiosulfate sulfurtransferase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0666 or TTC1258 or TTC0155)
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 2.8.1.-
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_R_TRED_c" stoichiometry="1"/>
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<speciesReference species="M_TSFA_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_O_TRED_c" stoichiometry="1"/>
     <speciesReference species="M_H2S_c" stoichiometry="1"/>
     <speciesReference species="M_SO3_c" stoichiometry="1"/>
  </listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
  </kineticLaw>
</reaction>
<reaction id="R_R630" name="formate dehydrogenase" reversible="true">
  <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TT_P0138
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 1.2.1.43/1.2.1.2
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
```

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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_CO2_c" stoichiometry="1"/>
     <speciesReference species="M_NADPH_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_NADP_c" stoichiometry="1"/>
     <speciesReference species="M_FOR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R631" name="formate-tetrahydrofolate ligase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1707
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 6.3.4.3
```

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Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
     <speciesReference species="M_THF_c" stoichiometry="1"/>
     <speciesReference species="M_FOR_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_FOLNA_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R632" name="dihydrofolate reductase" reversible="false">
   <notes>
```

```
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE ASSOCIATION: 
 SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
 EC Number: 1.5.1.3
 Confidence Level: 1
 AUTHORS: Energy and cofactors metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M_H_c" stoichiometry="1"/>
<speciesReference species="M NADPH c" stoichiometry="1"/>
<speciesReference species="M_DHF_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
<speciesReference species="M_NADP_c" stoichiometry="1"/>
<speciesReference species="M_THF_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
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IistOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
</listOfParameters>
</kineticLaw>
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</reaction>
<reaction id="R R633" name="2-oxoacid-ferredoxin oxidoreductase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1591
  SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
  EC Number: 1.2.7.2
  Confidence Level: 1
  AUTHORS: Energy and cofactors metabolism
  </body>
 </notes>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_PRCoA_c" stoichiometry="1"/>
 <speciesReference species="M_R_FRDX_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M CoA c" stoichiometry="1"/>
 <speciesReference species="M_AKB_c" stoichiometry="1"/>
 <speciesReference species="M_O_FRDX_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R634" name="methylenetetrahydrofolate reductase (ferredoxin)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1656
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 1.5.7.1
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
 <speciesReference species="M_R_FRDX_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_5MTHF_c" stoichiometry="1"/>
 <speciesReference species="M_O_FRDX_c" stoichiometry="2"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
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```
<parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R635" name="nitrilotriacetate monooxygenase component B, NADH-dependent flavin oxidoreductase"
reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC0052 or TTC1829)
     SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
     EC Number: 1.14.13.-
     Confidence Level: 1
     AUTHORS: Energy and cofactors metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_H_c" stoichiometry="1"/>
    <speciesReference species="M_NADH_c" stoichiometry="1"/>
    <speciesReference species="M_FMN_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_NAD_c" stoichiometry="1"/>
    <speciesReference species="M_FMNH2_c" stoichiometry="1"/>
   /listOfProducts>
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<listOfParameters>

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<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R636" name="thymidylate synthase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 2.1.1.45
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_dUMP_c" stoichiometry="1"/>
 <speciesReference species="M_5_10_MNTHF_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_dTMP_c" stoichiometry="1"/>
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<speciesReference species="M_DHF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R637" name="uridine nucleosidase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.2.2.3
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_URD_c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
     <speciesReference species="M D RIB c" stoichiometry="1"/>
     <speciesReference species="M_URA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R638" name="uridine phosphorylase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC1070
         SUBSYSTEM: Nucleotide Salvage Pathway
         EC Number: 2.4.2.3
         Confidence Level: 1
         AUTHORS: Nucleotides metabolism
         </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
```

```
<speciesReference species="M_URD_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_R1P_c" stoichiometry="1"/>
     <speciesReference species="M_URA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R639" name="cob(II)yrinic acid a,c-diamide reductase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TT_P0018 
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 1.16.8.1
        Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
```

```
listOfReactants>
 <speciesReference species="M FMNH2 c" stoichiometry="1"/>
 <speciesReference species="M_Co2ABYRDA_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="3"/>
 <speciesReference species="M_FMN_c" stoichiometry="1"/>
 <speciesReference species="M_CABYRDA_c" stoichiometry="2"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R640" name="adenosylcobinamide-phosphate guanylyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0023 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 2.7.7.62
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GTP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_ADNS_CBNAPi_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_ADNS_CBNA_GDP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R641" name="aminodeoxychorismate synthase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0355 
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
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EC Number: 2.6.1.85
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLN_c" stoichiometry="1"/>
 <speciesReference species="M_CORM_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M L GLU c" stoichiometry="1"/>
 <speciesReference species="M_4A4CORM_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R642" name="4-amino-4-deoxychorismate lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

```
GENE_ASSOCIATION: TTC1477
   SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
   EC Number: 4.1.3.38
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_4A4CORM_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_ABEE_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R643" name="putative deoxyribonucleotide triphosphate pyrophosphatase" reversible="false">
```

```
<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: TTC1290
     SUBSYSTEM: Nucleotide Salvage Pathway
     EC Number: 3.6.1.15
     Confidence Level: 1
     AUTHORS: Nucleotides metabolism
     </body>
</notes>
distOfReactants>
  <speciesReference species="M_UTP_c" stoichiometry="1"/>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_Pi_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M_UDP_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
  </listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R644" name="nucleoside-diphosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Nucleotide Salvage Pathway
  EC Number: 3.6.1.6
  Confidence Level: 1
  AUTHORS: Nucleotides metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R645" name="apyrase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.5
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CTP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="2"/>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_CMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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```
<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R646" name="putative deoxyribonucleotide triphosphate pyrophosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC1290
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.15
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CTP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_CDP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R647" name="nucleoside-diphosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Nucleotide Salvage Pathway
   EC Number: 3.6.1.6
   Confidence Level: 1
   AUTHORS: Nucleotides metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_CDP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
```

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<speciesReference species="M_CMP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R648" name="ornithine aminotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0553
  SUBSYSTEM: Arginine and Proline Metabolism
  EC Number: 2.6.1.13
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ORT_c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
     <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
     <speciesReference species="M_GLU_SA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R649" name="formate hydrogenlyase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Pyruvate Metabolism
         EC Number: 
         Confidence Level: 1
         AUTHORS: Carbohydrate metabolism
         </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_FOR_c" stoichiometry="1"/>
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</listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R650" name="phosphoserine aminotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Glycine and Serine Metabolism
  EC Number: 2.6.1.52
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
```

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<speciesReference species="M_L_GLU_c" stoichiometry="1"/>
 <speciesReference species="M 3POXPYR c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_PPTD_SER_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R651" name="3-phosphoserine phosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 3.1.3.3
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
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</notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_PPTD_SER_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R652" name="valine-pyruvate aminotransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1960
   SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
   EC Number: 2.6.1.66
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_L_VAL_c" stoichiometry="1"/>
     <speciesReference species="M_PYR_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_L_ALA_c" stoichiometry="1"/>
     <speciesReference species="M_2K3M_BUT_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R653" name="coproporphyrinogen oxidase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Cofactor and Prosthetic Group Biosynthesis
        EC Number: 1.3.3.3
```

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Confidence Level: 1
        AUTHORS: Energy and cofactors metabolism
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H_c" stoichiometry="2"/>
     <speciesReference species="M_O2_c" stoichiometry="1"/>
     <speciesReference species="M_CPPPHYRGN_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="2"/>
     <speciesReference species="M_CO2_c" stoichiometry="2"/>
     <speciesReference species="M_PPPHYRGN_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     defined and the control of t
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R654" name="quinate/shikimate dehydrogenase" reversible="false">
   <notes>
```

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<body xmlns="http://www.w3.org/1999/xhtml">
     GENE ASSOCIATION: TTC0688 
     SUBSYSTEM: Tyrosine, Tryptophan, and Phenylalanine Metabolism
     EC Number: 1.1.1.282
     Confidence Level: 1
     AUTHORS: Amino acid metabolism
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_H_c" stoichiometry="1"/>
  <speciesReference species="M NADH c" stoichiometry="1"/>
  <speciesReference species="M_DHY_SHK_c" stoichiometry="1"/>
</listOfReactants>
listOfProducts>
  <speciesReference species="M_NAD_c" stoichiometry="1"/>
  <speciesReference species="M_SHK_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

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</reaction>
<reaction id="R R655" name="serine hydroxymethyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1160
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 2.1.2.1
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 <speciesReference species="M_THF_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
 <speciesReference species="M H2O c" stoichiometry="1"/>
 <speciesReference species="M_METHF_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R656" name="serine-glyoxylate transaminase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 2.6.1.45
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 <speciesReference species="M_GLOXT_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
 <speciesReference species="M_HY_PYR_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R657" name="malate-CoA ligase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 6.2.1.9
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_MAL_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_MALYCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R658" name="malyl-CoA lyase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Glycine and Serine Metabolism
   EC Number: 4.1.3.24
   Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_MALYCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ACoA_c" stoichiometry="1"/>
 <speciesReference species="M_GLOXT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
```

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<math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R659" name="acyl-CoA hydrolase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC1452 
        SUBSYSTEM: Glycine and Serine Metabolism
        EC Number: 3.1.2.20 
        Confidence Level: 1
        AUTHORS: Amino acid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_H2O_c" stoichiometry="2"/>
     <speciesReference species="M_ACoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="5"/>
     <speciesReference species="M_CoA_c" stoichiometry="1"/>
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<speciesReference species="M_GLOXT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R660" name="malate dehydrogenase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0144
  SUBSYSTEM: Anaplerotic Reactions
  EC Number: 1.1.1.40
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M MAL c" stoichiometry="1"/>
 </listOfReactants>
```

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distOfProducts>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R661" name="fructose 1,6-bisphosphatase II " reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1081
   SUBSYSTEM: Glycolysis/Gluconeogenesis
   EC Number: 3.1.3.11
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
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<speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M FBP c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_F6P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R662" name="glucose-1-phosphatase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Glycolysis/Gluconeogenesis
   EC Number: 3.1.3.10
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
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</notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_G1P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_D_GLC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R663" name="phosphate acetyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Pyruvate Metabolism
   EC Number: 2.3.1.8
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
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</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M_ACoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_CoA_c" stoichiometry="1"/>
     <speciesReference species="M_ACPi_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     defined and the control of t
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R664" name="acetolactate synthase large subunit" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TTC0852
         SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
         EC Number: 2.2.1.6
```

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Confidence Level: 1
   AUTHORS: Amino acid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_PYR_c" stoichiometry="1"/>
 <speciesReference species="M_AKB_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M_AC_HYBUTNA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R665" name="ketol-acid reductoisomerase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
```

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GENE_ASSOCIATION: TTC0850
  SUBSYSTEM: Valine, Leucine, and Isoleucine Metabolism
  EC Number: 1.1.1.86
  Confidence Level: 1
  AUTHORS: Amino acid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_AC_HYBUTNA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_DHY_MPENTA_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
```

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<reaction id="R_R666" name="2-oxoglutarate ferredoxin oxidoreductase subunit beta" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TTC1592
   SUBSYSTEM: Citric Acid Cycle
   EC Number: 1.2.7.3
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_AKG_c" stoichiometry="1"/>
 <speciesReference species="M_O_FRDX_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CO2_c" stoichiometry="1"/>
 <speciesReference species="M SUCCoA c" stoichiometry="1"/>
 <speciesReference species="M_R_FRDX_c" stoichiometry="2"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R667" name="fatty acid synthesis; lumped" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and
TTC1463 and TTC0048)
     SUBSYSTEM: Membrane Lipid Metabolism
     EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H_c" stoichiometry="16"/>
    <speciesReference species="M NADPH c" stoichiometry="11"/>
    <speciesReference species="M_MALCoA_c" stoichiometry="6"/>
    <speciesReference species="M_MBUTNCoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H2O_c" stoichiometry="5"/>
    <speciesReference species="M_CO2_c" stoichiometry="6"/>
    <speciesReference species="M CoA c" stoichiometry="7"/>
    <speciesReference species="M_NADP_c" stoichiometry="11"/>
    <speciesReference species="M_AI171_c" stoichiometry="1"/>
   </listOfProducts>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R668" name="fatty acid synthesis; lumped" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and
TTC1463 and TTC0048)
     SUBSYSTEM: Membrane Lipid Metabolism
     EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M H c" stoichiometry="14"/>
    <speciesReference species="M_NADPH_c" stoichiometry="10"/>
    <speciesReference species="M_MALCoA_c" stoichiometry="5"/>
    <speciesReference species="M_MBUTNCoA_c" stoichiometry="1"/>
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<kineticLaw>

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</listOfReactants>
          distOfProducts>
            <speciesReference species="M_H2O_c" stoichiometry="4"/>
            <speciesReference species="M_CO2_c" stoichiometry="5"/>
            <speciesReference species="M_CoA_c" stoichiometry="6"/>
            <speciesReference species="M_NADP_c" stoichiometry="10"/>
            <speciesReference species="M_AI150_c" stoichiometry="1"/>
          </listOfProducts>
          <kineticLaw>
            <math xmlns="http://www.w3.org/1998/Math/MathML">
               <ci> FLUX VALUE </ci>
            definition of the control of
               <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
               <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
            /listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R R669" name="fatty acid synthesis; lumped" reversible="false">
          <notes>
            <body xmlns="http://www.w3.org/1999/xhtml">
               GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and
TTC1463 and TTC0048)
               SUBSYSTEM: Membrane Lipid Metabolism
               EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
               Confidence Level: 1
               AUTHORS: Lipid metabolism
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</body>
 </notes>
 listOfReactants>
  <speciesReference species="M_H_c" stoichiometry="14"/>
  <speciesReference species="M_NADPH_c" stoichiometry="10"/>
  <speciesReference species="M_MALCoA_c" stoichiometry="5"/>
  <speciesReference species="M_IVCoA_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
  <speciesReference species="M_H2O_c" stoichiometry="4"/>
  <speciesReference species="M CO2 c" stoichiometry="5"/>
  <speciesReference species="M_CoA_c" stoichiometry="6"/>
  <speciesReference species="M_NADP_c" stoichiometry="10"/>
  <speciesReference species="M_I150_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
  distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R670" name="fatty acid synthesis; lumped" reversible="false">
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<notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and
TTC1463 and TTC0048)
     SUBSYSTEM: Membrane Lipid Metabolism
     EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H_c" stoichiometry="17"/>
    <speciesReference species="M_NADPH_c" stoichiometry="12"/>
    <speciesReference species="M_MALCoA_c" stoichiometry="6"/>
    <speciesReference species="M_2M_PROCoA_c" stoichiometry="1"/>
   </listOfReactants>
   ducts>
    <speciesReference species="M H2O c" stoichiometry="5"/>
    <speciesReference species="M_CO2_c" stoichiometry="6"/>
    <speciesReference species="M_CoA_c" stoichiometry="7"/>
    <speciesReference species="M_NADP_c" stoichiometry="12"/>
    <speciesReference species="M_I160_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
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definition of the control of

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R671" name="fatty acid synthesis; lumped" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     <GENE ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and</p>
TTC1463 and TTC0048)
     SUBSYSTEM: Membrane Lipid Metabolism
     EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_H_c" stoichiometry="16"/>
    <speciesReference species="M_NADPH_c" stoichiometry="12"/>
    <speciesReference species="M_MALCoA_c" stoichiometry="6"/>
    <speciesReference species="M_IVCoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H2O_c" stoichiometry="5"/>
    <speciesReference species="M_CO2_c" stoichiometry="6"/>
    <speciesReference species="M_CoA_c" stoichiometry="7"/>
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<speciesReference species="M_NADP_c" stoichiometry="12"/>
    <speciesReference species="M I170 c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R672" name="fatty acid synthesis; lumped" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     <GENE ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and</p>
TTC1463 and TTC0048)
     SUBSYSTEM: Membrane Lipid Metabolism
     EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H_c" stoichiometry="12"/>
```

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<speciesReference species="M_NADPH_c" stoichiometry="8"/>
            <speciesReference species="M MALCoA c" stoichiometry="4"/>
            <speciesReference species="M_IVCoA_c" stoichiometry="1"/>
          </listOfReactants>
          distOfProducts>
            <speciesReference species="M_H2O_c" stoichiometry="3"/>
            <speciesReference species="M_CO2_c" stoichiometry="4"/>
            <speciesReference species="M_CoA_c" stoichiometry="5"/>
            <speciesReference species="M_NADP_c" stoichiometry="8"/>
            <speciesReference species="M_I130_c" stoichiometry="1"/>
          </listOfProducts>
          <kineticLaw>
            <math xmlns="http://www.w3.org/1998/Math/MathML">
              <ci> FLUX VALUE </ci>
            definition of the control of
               <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
               <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
            </listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R_R673" name="fatty acid synthesis; lumped" reversible="false">
          <notes>
            <body xmlns="http://www.w3.org/1999/xhtml">
               <GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and</p>
TTC1463 and TTC0048)
               SUBSYSTEM: Membrane Lipid Metabolism
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EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
 Confidence Level: 1
 AUTHORS: Lipid metabolism
 </body>
</notes>
distOfReactants>
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<speciesReference species="M_NADPH_c" stoichiometry="6"/>
<speciesReference species="M_MALCoA_c" stoichiometry="3"/>
<speciesReference species="M_IVCoA_c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_H2O_c" stoichiometry="2"/>
<speciesReference species="M_CO2_c" stoichiometry="3"/>
<speciesReference species="M_CoA_c" stoichiometry="6"/>
<speciesReference species="M_NADP_c" stoichiometry="6"/>
<speciesReference species="M_I110_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
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distOfParameters>
 <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
</listOfParameters>
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</kineticLaw>
  </reaction>
  <reaction id="R_R674" name="fatty acid synthesis; lumped" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and
TTC1463 and TTC0048 and TTC1678)
     SUBSYSTEM: Membrane Lipid Metabolism
     EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H_c" stoichiometry="20"/>
    <speciesReference species="M_ACoA_c" stoichiometry="1"/>
    <speciesReference species="M_NADPH_c" stoichiometry="14"/>
    <speciesReference species="M MALCoA c" stoichiometry="7"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H2O_c" stoichiometry="6"/>
    <speciesReference species="M_CO2_c" stoichiometry="7"/>
    <speciesReference species="M_CoA_c" stoichiometry="8"/>
    <speciesReference species="M_NADP_c" stoichiometry="14"/>
    <speciesReference species="M C160 c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
                   definition of the control of
                        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
                   /listOfParameters>
                </kineticLaw>
           </reaction>
           <reaction id="R R675" name="fatty acid synthesis; lumped" reversible="false">
                <notes>
                   <body xmlns="http://www.w3.org/1999/xhtml">
                        <FINAL ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and (TTC0394) and (TTC0047 or TTC0394) and (TTC0047 or TTC0394)
TTC1463 and (TTC0238 or TTC0536 or TTC779 or TTC1552 or TTC1575 or TT_P0074) and TTC0048 and TTC1678)
                        SUBSYSTEM: Membrane Lipid Metabolism
                        EC Number: 2.3.1.180 and (2.3.1.179 or 2.3.1.180) and 1.1.1.100 and 4.2.1.59
                        Confidence Level: 1
                        AUTHORS: Lipid metabolism
                        </body>
                </notes>
                listOfReactants>
                   <speciesReference species="M_H_c" stoichiometry="21"/>
                   <speciesReference species="M_ACoA_c" stoichiometry="1"/>
                   <speciesReference species="M NADPH c" stoichiometry="15"/>
                   <speciesReference species="M_O2_c" stoichiometry="1"/>
                   <speciesReference species="M_MALCoA_c" stoichiometry="7"/>
                </listOfReactants>
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distOfProducts>
            <speciesReference species="M H2O c" stoichiometry="6"/>
            <speciesReference species="M_CO2_c" stoichiometry="7"/>
            <speciesReference species="M_CoA_c" stoichiometry="8"/>
            <speciesReference species="M_NADP_c" stoichiometry="15"/>
            <speciesReference species="M_C161_c" stoichiometry="1"/>
          </listOfProducts>
          <kineticLaw>
            <math xmlns="http://www.w3.org/1998/Math/MathML">
               <ci> FLUX_VALUE </ci>
            definition of the control of
               <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
               <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
               <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
            /listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R_R676" name="fatty acid oxidation; lumped" reversible="false">
          <notes>
            <body xmlns="http://www.w3.org/1999/xhtml">
               <FINAL CONTROL OF SECTION AND ACCURATION: ((TTC0236 or TTC0342) and (TT P0074 or TTC0238 or TTC0536) and (TTC0604 or TTC1697 or TTC1697 or TTC0536).</p>
TTC1768) and (TTC0331 or TTC0534) and (TTC0623 or TTC0535))
               SUBSYSTEM: Membrane Lipid Metabolism
               EC Number: 1.3.8.- and 4.2.1.17 and 1.1.1.35 and 2.3.1.16
               Confidence Level: 1
               AUTHORS: Lipid metabolism
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</body>
 </notes>
 listOfReactants>
  <speciesReference species="M_H2O_c" stoichiometry="7"/>
  <speciesReference species="M_NAD_c" stoichiometry="7"/>
  <speciesReference species="M_CoA_c" stoichiometry="7"/>
  <speciesReference species="M_NADPH_c" stoichiometry="1"/>
  <speciesReference species="M_O2_c" stoichiometry="7"/>
  <speciesReference species="M_C161CoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
  <speciesReference species="M H c" stoichiometry="6"/>
  <speciesReference species="M_NADH_c" stoichiometry="7"/>
  <speciesReference species="M_ACoA_c" stoichiometry="8"/>
  <speciesReference species="M_NADP_c" stoichiometry="1"/>
  <speciesReference species="M_H2O2_c" stoichiometry="7"/>
 /listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
  <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
 </kineticLaw>
</reaction>
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<reaction id="R_R677" name="fatty acid oxidation; lumped" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: ((TTC0236 or TTC0342) and (TT_P0074 or TTC0238 or TTC0536) and (TTC0604 or TTC1697 or
TTC1768) and (TTC0331 or TTC0534) and (TTC0623 or TTC0535))
     SUBSYSTEM: Membrane Lipid Metabolism
     EC Number: 1.3.8.- and 4.2.1.17 and 1.1.1.35 and 2.3.1.16
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_H2O_c" stoichiometry="7"/>
    <speciesReference species="M_NAD_c" stoichiometry="7"/>
    <speciesReference species="M_CoA_c" stoichiometry="7"/>
    <speciesReference species="M_O2_c" stoichiometry="6"/>
    <speciesReference species="M_C161CoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_H_c" stoichiometry="7"/>
    <speciesReference species="M_NADH_c" stoichiometry="7"/>
    <speciesReference species="M_ACoA_c" stoichiometry="8"/>
    <speciesReference species="M_H2O2_c" stoichiometry="6"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R678" name="fatty acid coA--ligase" reversible="true">
 <notes>
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   GENE ASSOCIATION: (TTC0079 or TTC1065 or TTC1099)
   SUBSYSTEM: Membrane Lipid Metabolism
   EC Number: 6.2.1.3
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_AI171_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_AMP_c" stoichiometry="1"/>
 <speciesReference species="M Al171CoA c" stoichiometry="1"/>
 </listOfProducts>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
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 distOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
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  GENE_ASSOCIATION: (TTC0079 or TTC1065 or TTC1099)
  SUBSYSTEM: Membrane Lipid Metabolism
  EC Number: 6.2.1.3
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
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 <speciesReference species="M_ATP_c" stoichiometry="1"/>
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 <speciesReference species="M_AI150_c" stoichiometry="1"/>
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 distOfProducts>
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<kineticLaw>

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     <speciesReference species="M AMP c" stoichiometry="1"/>
     <speciesReference species="M_AI150CoA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
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     definition of the control of
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        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R680" name="fatty acid coA--ligase" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: (TTC0079 or TTC1065 or TTC1099)
        SUBSYSTEM: Membrane Lipid Metabolism
        EC Number: 6.2.1.3
        Confidence Level: 1
        AUTHORS: Lipid metabolism
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
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<speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M I150 c" stoichiometry="1"/>
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 <speciesReference species="M_I150CoA_c" stoichiometry="1"/>
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 IistOfParameters>
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   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
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<reaction id="R_R681" name="fatty acid coA--ligase" reversible="true">
 <notes>
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   SUBSYSTEM: Membrane Lipid Metabolism
   EC Number: 6.2.1.3
   Confidence Level: 1
   AUTHORS: Lipid metabolism
```

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</body>
 </notes>
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  <speciesReference species="M_I160_c" stoichiometry="1"/>
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 distOfProducts>
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  <speciesReference species="M_AMP_c" stoichiometry="1"/>
  <speciesReference species="M_I160CoA_c" stoichiometry="1"/>
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 <kineticLaw>
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   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R682" name="fatty acid coA--ligase" reversible="true">
 <notes>
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   SUBSYSTEM: Membrane Lipid Metabolism
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EC Number: 6.2.1.3
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
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 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_I170_c" stoichiometry="1"/>
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   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R683" name="fatty acid coA--ligase" reversible="true">
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<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: (TTC0079 or TTC1065 or TTC1099)
 SUBSYSTEM: Membrane Lipid Metabolism
 EC Number: 6.2.1.3
 Confidence Level: 1
 AUTHORS: Lipid metabolism
 </body>
</notes>
listOfReactants>
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distOfProducts>
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<speciesReference species="M_AMP_c" stoichiometry="1"/>
<speciesReference species="M C160CoA c" stoichiometry="1"/>
</listOfProducts>
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<listOfParameters>
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 <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
 <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R684" name="fatty acid coA--ligase" reversible="true">
 <notes>
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   SUBSYSTEM: Membrane Lipid Metabolism
   EC Number: 6.2.1.3
  Confidence Level: 1
   AUTHORS: Lipid metabolism
  </body>
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 listOfReactants>
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 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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<parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R685" name="lycopene epsilon-cyclase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Carotenoid biosynthesis
  EC Number: 5.5.1.18
  Confidence Level: 1
  AUTHORS: Carotenoid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_LCPN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_gCARO_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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<parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R686" name="lycopene beta-cyclase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Carotenoid biosynthesis
  EC Number: 5.5.1.18
  Confidence Level: 1
  AUTHORS: Carotenoid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_gCARO_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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 </listOfProducts>
 <kineticLaw>
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  <ci> FLUX_VALUE </ci>
 <listOfParameters>
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   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R687" name="UTP--glucose-1-phosphate uridylyltransferase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Alternate Carbon Metabolism
   EC Number: 
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_UTP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_G1P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PPi_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_GLU_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 distOfParameters>
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   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R688" name="beta-carotene hydroxylase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TT P0059
   SUBSYSTEM: Carotenoid biosynthesis
   EC Number: 
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_bCARO_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
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<speciesReference species="M_NAD_c" stoichiometry="1"/>
 <speciesReference species="M CRTX c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R689" name="beta-cryptoxanthin hydroxylase " reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: TT P0059
  SUBSYSTEM: Carotenoid biosynthesis
  EC Number: 
  Confidence Level: 1
  AUTHORS: Carotenoid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
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<speciesReference species="M_O2_c" stoichiometry="1"/>
     <speciesReference species="M CRTX c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_ZXT_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R690" name="thermocryptoxanthin hydroxylase " reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TT_P0059
        SUBSYSTEM: Carotenoid biosynthesis
        EC Number: 
        Confidence Level: 1
        AUTHORS: Carotenoid metabolism
```

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</body>
 </notes>
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 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 <speciesReference species="M_tCRTX_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_tZXT_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M NAD c" stoichiometry="1"/>
 </or>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R691" name="beta-cryptoxanthin glucosyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0062
```

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SUBSYSTEM: Carotenoid biosynthesis
   EC Number: 
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_UDP_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_CRTX_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
 <speciesReference species="M_bCRTX_GLU_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R692" name="beta-cryptoxanthin acyltransferase (C11:0)" reversible="false">
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<notes>
<body xmlns="http://www.w3.org/1999/xhtml">
 GENE_ASSOCIATION: TT_P0061
 SUBSYSTEM: Carotenoid biosynthesis
 EC Number: 
 Confidence Level: 1
 AUTHORS: Carotenoid metabolism
 </body>
</notes>
listOfReactants>
<speciesReference species="M I150CoA c" stoichiometry="0.334"/>
<speciesReference species="M_AI150CoA_c" stoichiometry="0.069"/>
<speciesReference species="M_I160CoA_c" stoichiometry="0.047"/>
<speciesReference species="M_C160CoA_c" stoichiometry="0.014"/>
<speciesReference species="M_C161CoA_c" stoichiometry="0.0015"/>
<speciesReference species="M_I170CoA_c" stoichiometry="0.45"/>
<speciesReference species="M_AI171CoA_c" stoichiometry="0.075"/>
<speciesReference species="M bCRTX GLU c" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_CoA_c" stoichiometry="1"/>
<speciesReference species="M_tCRTX_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <ci> FLUX_VALUE </ci>
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<listOfParameters>

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R693" name="zeaxanthin glucosyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0062
   SUBSYSTEM: Carotenoid biosynthesis
   EC Number: 
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_UDP_GLU_c" stoichiometry="1"/>
 <speciesReference species="M_ZXT_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
 <speciesReference species="M_ZXT_GLU_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 distOfParameters>
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   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R694" name="zeaxanthin acyltransferase (C13:0)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TT P0061
   SUBSYSTEM: Carotenoid biosynthesis
   EC Number: 
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_I150CoA_c" stoichiometry="0.334"/>
 <speciesReference species="M_AI150CoA_c" stoichiometry="0.069"/>
 <speciesReference species="M_I160CoA_c" stoichiometry="0.047"/>
 <speciesReference species="M_C160CoA_c" stoichiometry="0.014"/>
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<speciesReference species="M_ZXT_GLU_c" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
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     <speciesReference species="M_CoA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
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         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R695" name="thermozeaxanthin glucosyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: TT_P0062
         SUBSYSTEM: Carotenoid biosynthesis
         EC Number: 
         Confidence Level: 1
         AUTHORS: Carotenoid metabolism
         </body>
   </notes>
```

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listOfReactants>
 <speciesReference species="M tZXT c" stoichiometry="1"/>
 <speciesReference species="M_UDP_GLU_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_UDP_c" stoichiometry="1"/>
 <speciesReference species="M_tZXT_GLU_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R696" name="thermozeaxanthin acyltransferase (C13-C13)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: TT_P0061
   SUBSYSTEM: Carotenoid biosynthesis
   EC Number: 
   Confidence Level: 1
   AUTHORS: Carotenoid metabolism
```

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</body>
  </notes>
  listOfReactants>
     <speciesReference species="M_I150CoA_c" stoichiometry="0.334"/>
     <speciesReference species="M_AI150CoA_c" stoichiometry="0.069"/>
     <speciesReference species="M_I160CoA_c" stoichiometry="0.047"/>
     <speciesReference species="M_C160CoA_c" stoichiometry="0.014"/>
     <speciesReference species="M_C161CoA_c" stoichiometry="0.0015"/>
     <speciesReference species="M_I170CoA_c" stoichiometry="0.45"/>
     <speciesReference species="M_AI171CoA_c" stoichiometry="0.075"/>
     <speciesReference species="M_tZXT_GLU_c" stoichiometry="1"/>
  </listOfReactants>
  distOfProducts>
     <speciesReference species="M_CoA_c" stoichiometry="1"/>
     <speciesReference species="M_tbZXT_c" stoichiometry="1"/>
  /listOfProducts>
  <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
       <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     /listOfParameters>
  </kineticLaw>
</reaction>
```

```
<reaction id="R_R697" name="glucosamine-6-phosphate deaminase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC1074
  SUBSYSTEM: 
  EC Number: 3.5.99.6
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_GLUSAP_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_F6P_c" stoichiometry="1"/>
 <speciesReference species="M_NH4_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R698" name="acetyl-CoA C-acetyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: (TTC0191 or TTC0330)
         SUBSYSTEM: Butanoate metabolism
         EC Number: 2.3.1.9
         Confidence Level: 1
         AUTHORS: Lipid metabolism
         </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_ACoA_c" stoichiometry="2"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_CoA_c" stoichiometry="1"/>
     <speciesReference species="M ACACoA c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R699" name="(R)-3-Hydroxybutanoyl-CoA:NADP+ oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0898
  SUBSYSTEM: Butanoate metabolism
  EC Number: 1.1.1.157
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_ACACoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_RHY_BUTCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 IistOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R700" name="beta-ketothiolase " reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: (TTC0191 or TTC0330 or TTC0525 or TTC0623)
   SUBSYSTEM: Butanoate metabolism
   EC Number: 
   Confidence Level: 1
   AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M ACoA c" stoichiometry="1"/>
 <speciesReference species="M_PRCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_KVCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
   <ci> FLUX VALUE </ci>
```

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<parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R701" name="(R)-3-Hydroxybutanoyl-CoA:NADP+ oxidoreductase" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: TTC0898
   SUBSYSTEM: Butanoate metabolism
   EC Number: 
   Confidence Level: 1
   AUTHORS: Lipid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="3"/>
 <speciesReference species="M_NADPH_c" stoichiometry="1"/>
 <speciesReference species="M_KVCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_HVCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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<listOfParameters>

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R702" name="Acyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Butanoate metabolism
  EC Number: 2.3.1.-
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_RHY_BUTCoA_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CoA_c" stoichiometry="2"/>
 <speciesReference species="M_PHB_c" stoichiometry="1"/>
 </listOfProducts>
```

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<kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R703" name="Acyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Butanoate metabolism
  EC Number: 
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_HVCoA_c" stoichiometry="2"/>
 </listOfReactants>
 ducts>
 <speciesReference species="M_CoA_c" stoichiometry="1"/>
 <speciesReference species="M_PHV_c" stoichiometry="1"/>
```

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</listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    <listOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R R704" name="fatty acid synthesis; lumped" reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and
TTC1463 and TTC0048 and TTC1678)
     SUBSYSTEM: Butanoate metabolism
     EC Number: 
     Confidence Level: 1
     AUTHORS: Lipid metabolism
     </body>
   </notes>
   distOfReactants>
    <speciesReference species="M_H_c" stoichiometry="4"/>
    <speciesReference species="M_ACoA_c" stoichiometry="2"/>
    <speciesReference species="M_NADPH_c" stoichiometry="4"/>
```

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<speciesReference species="M_RHY_BUTCoA_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H2O_c" stoichiometry="2"/>
     <speciesReference species="M_CoA_c" stoichiometry="2"/>
     <speciesReference species="M_NADP_c" stoichiometry="4"/>
     <speciesReference species="M_HY_OCTCoA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R705" name="Acyltransferase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Butanoate metabolism
        EC Number: 
        Confidence Level: 1
        AUTHORS: Lipid metabolism
```

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</body>
   </notes>
   <speciesReference species="M_HY_OCTCoA_c" stoichiometry="2"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_CoA_c" stoichiometry="2"/>
    <speciesReference species="M_PHO_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX VALUE </ci>
    distOfParameters>
     <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R706" name="fatty acid synthesis; lumped" reversible="true">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and
TTC1463 and TTC0048 and TTC1678)
     SUBSYSTEM: Butanoate metabolism
     EC Number: 
     Confidence Level: 1
```

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AUTHORS: Lipid metabolism
   </body>
 </notes>
 listOfReactants>
  <speciesReference species="M_H_c" stoichiometry="2"/>
  <speciesReference species="M_ACoA_c" stoichiometry="1"/>
  <speciesReference species="M_NADPH_c" stoichiometry="2"/>
  <speciesReference species="M_HY_OCTCoA_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
  <speciesReference species="M_H2O_c" stoichiometry="1"/>
  <speciesReference species="M_CoA_c" stoichiometry="1"/>
  <speciesReference species="M_NADP_c" stoichiometry="2"/>
  <speciesReference species="M_HY_DECCoA_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
  distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R707" name="Acyltransferase" reversible="false">
```

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<notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Butanoate metabolism
         EC Number: 
         Confidence Level: 1
         AUTHORS: Lipid metabolism
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_HY_DECCoA_c" stoichiometry="2"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_CoA_c" stoichiometry="2"/>
      <speciesReference species="M_PHD_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      defined the control of the c
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
```

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<reaction id="R_R708" name="fatty acid synthesis; lumped" reversible="true">
           <notes>
              <body xmlns="http://www.w3.org/1999/xhtml">
                 GENE_ASSOCIATION: ((TTC0049 or TTC0045) and (TTC0045 or (TTC0049 or TTC0343)) and (TTC0047 or TTC0394) and
TTC1463 and TTC0048 and TTC1678)
                 SUBSYSTEM: Butanoate metabolism
                 EC Number: 
                 Confidence Level: 1
                 AUTHORS: Lipid metabolism
                 </body>
           </notes>
           listOfReactants>
              <speciesReference species="M_H_c" stoichiometry="2"/>
              <speciesReference species="M_ACoA_c" stoichiometry="1"/>
              <speciesReference species="M_NADPH_c" stoichiometry="2"/>
              <speciesReference species="M_HY_DECCoA_c" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M_H2O_c" stoichiometry="1"/>
              <speciesReference species="M_CoA_c" stoichiometry="1"/>
              <speciesReference species="M_NADP_c" stoichiometry="2"/>
              <speciesReference species="M_HY_DODECCoA_c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
                 <ci> FLUX_VALUE </ci>
              definition of the control of
```

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<parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R709" name="Acyltransferase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Butanoate metabolism
  EC Number: 
  Confidence Level: 1
  AUTHORS: Lipid metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_HY_DODECCoA_c" stoichiometry="2"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_CoA_c" stoichiometry="2"/>
 <speciesReference species="M_PHDD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
```

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<listOfParameters>
   <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R710" name="gluconokinase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE ASSOCIATION: 
   SUBSYSTEM: Pentose Phosphate Pathway
   EC Number: 2.7.1.12
   Confidence Level: 1
   AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_GLCN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_GLCN6P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R711" name="gluconate 5-dehydrogenase (NAD+)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0235
  SUBSYSTEM: 
  EC Number: 1.1.1.69
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_NADH_c" stoichiometry="1"/>
 <speciesReference species="M_DHYGLCN_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_NAD_c" stoichiometry="1"/>
```

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<speciesReference species="M_GLCN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R712" name="gluconate 5-dehydrogenase (NADP+)" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TTC0235
  SUBSYSTEM: 
  EC Number: 1.1.1.69
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M NADPH c" stoichiometry="1"/>
 <speciesReference species="M_DHYGLCN_c" stoichiometry="1"/>
```

```
</listOfReactants>
 distOfProducts>
 <speciesReference species="M_NADP_c" stoichiometry="1"/>
 <speciesReference species="M_GLCN_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R713" name="gluconolactonase" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Pentose Phosphate Pathway
  EC Number: 3.1.1.17
  Confidence Level: 1
  AUTHORS: Carbohydrate metabolism
  </body>
 </notes>
```

```
<speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M GLC LACN c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_GLCN_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R714" name="phosphogluconate dehydratase" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: TTC0871
        SUBSYSTEM: Pentose Phosphate Pathway
        EC Number: 4.2.1.12
        Confidence Level: 1
        AUTHORS: Carbohydrate metabolism
        </body>
```

```
</notes>
 listOfReactants>
 <speciesReference species="M_GLCN6P_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_DHY_DOP_GLUCN_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R715" name="NADH:ubiquinone oxidoreductase I" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Oxidative Phosphorylation
   EC Number: 1.6.5.-
   Confidence Level: 1
   AUTHORS: Energy and cofactors metabolism
```

```
</body>
   </notes>
   listOfReactants>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_NADH_c" stoichiometry="1"/>
     <speciesReference species="M_MQ_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_NAD_c" stoichiometry="1"/>
     <speciesReference species="M_MQL_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R716" name="Glucose transport via ABC transporter" reversible="false">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: ((TTC0326 or TTC0327) and TTC0328)
        SUBSYSTEM: Transport, Extracellular
        EC Number:
```

```
Confidence Level: 1
   AUTHORS: Transport
   </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_D_GLC_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_D_GLC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R717" name="Water transport" reversible="true">
```

```
<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R718" name="Oxygen transport" reversible="false">
```

```
<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_O2_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_O2_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R719" name="Sulfate transport" reversible="false">
```

```
<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_SO4_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_SO4_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 IistOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R720" name="Phosphate transport" reversible="true">
```

```
<notes>
  <body xmlns="http://www.w3.org/1999/xhtml">
     GENE_ASSOCIATION: (TTC1724 and TTC1725)
     SUBSYSTEM: Transport, Extracellular
     EC Number: 
     Confidence Level: 1
     AUTHORS: Transport
     </body>
</notes>
listOfReactants>
  <speciesReference species="M_H_e" stoichiometry="1"/>
  <speciesReference species="M_Pi_e" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
  <speciesReference species="M_Pi_c" stoichiometry="1"/>
  <speciesReference species="M_H_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
  <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
  definition of the control of
     <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  </listOfParameters>
</kineticLaw>
```

```
</reaction>
<reaction id="R R721" name="Carbon dioxide transport" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   <speciesReference species="M_CO2_c" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_CO2_e" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R722" name="Acetate transport" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   <speciesReference species="M_AC_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_AC_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R723" name="D-Alanyl-D-alanine transport via ABC system" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: ((TTC1270 or TTC0972) and TTC0973)
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M_D_ALA_D_ALA_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_D_ALA_D_ALA_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R724" name="L-Arginine transport" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   <speciesReference species="M_L_ARG_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_L_ARG_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R725" name="L-Asparagine transport" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   <speciesReference species="M_L_ASN_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_L_ASN_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R726" name="Citrate transport" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   <speciesReference species="M_CIT_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_CIT_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R727" name="Ethanol transport" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   <speciesReference species="M_ETH_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_ETH_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R728" name="D-Fructose 1-phosphate transport" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   <speciesReference species="M_F1P_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
      <speciesReference species="M_F1P_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
```

```
</reaction>
<reaction id="R R729" name="L-Fuculose 1-phosphate transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_FUCL1P_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_FUCL1P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 IistOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
```

```
</reaction>
<reaction id="R R730" name="Ferrous ion transport via diffusion" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: (TTC0354 or TTC0776 or TTC1358)
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 <speciesReference species="M_Fe2_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Fe2_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 IistOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
```

```
</reaction>
<reaction id="R R731" name="D-Fructose transport via ABC transporter" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: ((TTC0326 or TTC0327) and TTC0328)
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_D_FRU_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_D_FRU_c" stoichiometry="1"/>
 </listOfProducts>
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 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R732" name="Fumarate transport via proton symport" reversible="true">
 <notes>
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  GENE_ASSOCIATION: TT_P0033 
   SUBSYSTEM: Transport, Extracellular
   EC Number: 
   Confidence Level: 1
   AUTHORS: Transport
  </body>
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 <speciesReference species="M_FUM_e" stoichiometry="1"/>
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 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_FUM_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R733" name="alpha-D-Glucosamine 1-phosphate transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_GLUCSA1P_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_GLUCSA1P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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```
<listOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R734" name="D-Glucosamine 6-phosphate transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GLUSAP_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_GLUSAP_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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<listOfParameters>
  <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R735" name="Glycolaldehyde transport" reversible="true">
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  GENE ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_GLYCALD_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_GLYCALD_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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<parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R736" name="D-Glutamate transport" reversible="true">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
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 listOfReactants>
 <speciesReference species="M_D_GLU_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GLU_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
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<reaction id="R_R737" name="Glycolate transport" reversible="true">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
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 distOfProducts>
 <speciesReference species="M_HY_AC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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<listOfParameters>
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  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R738" name="D-Glycerate transport" reversible="true">
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 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_D_GLCT_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_D_GLCT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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<parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
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  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R739" name="Glycerol transport" reversible="true">
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 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GLYCRL_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_GLYCRL_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R740" name="Glycine transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_GLY_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_GLY_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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<listOfParameters>
  <parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R741" name="Hydrogen sulfide transport" reversible="true">
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 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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 distOfProducts>
 <speciesReference species="M_H2S_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R742" name="L-Homocysteine transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_HCYS_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_HCYS_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
```

```
<parameter id="LOWER BOUND" value="-1000" units="mmol per gDW per hr" constant="true"/>
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      <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    </listOfParameters>
    </kineticLaw>
  </reaction>
  <reaction id="R_R743" name="L-Isoleucine transport via ABC system" reversible="false">
    <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
      <P>GENE ASSOCIATION: ((TTC0219 or TTC0334 or TTC0970 or TTC0600 or TTC0083) and (TTC0218 or TTC0335 or
TTC0969 or TTC0078)) and ((TTC0220 or TTC0337 or TTC0598 or TTC0967 or TTC0080) and (TTC216 or TTC0968 or
TTC0081))
      SUBSYSTEM: Transport, Extracellular
      EC Number: 
      Confidence Level: 1
      AUTHORS: Transport
      </body>
    </notes>
    distOfReactants>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_L_ILE_e" stoichiometry="1"/>
    </listOfReactants>
    distOfProducts>
    <speciesReference species="M_L_ILE_c" stoichiometry="1"/>
    <speciesReference species="M_ADP_c" stoichiometry="1"/>
    <speciesReference species="M_Pi_c" stoichiometry="1"/>
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</listOfProducts>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
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         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R744" name="L-Lysine transport " reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
         SUBSYSTEM: Transport, Extracellular
         EC Number: 
         Confidence Level: 1
         AUTHORS: Transport
        </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_L_LYS_e" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
      <speciesReference species="M_L_LYS_c" stoichiometry="1"/>
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</listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R745" name="L-Malate transport via proton symport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: TT_P0033 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
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 <speciesReference species="M_MAL_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
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<speciesReference species="M_H_c" stoichiometry="2"/>
             <speciesReference species="M MAL c" stoichiometry="1"/>
          </listOfProducts>
          <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
               <ci> FLUX_VALUE </ci>
             <listOfParameters>
                <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R_R746" name="Maltose transport via ABC transporter" reversible="false">
          <notes>
             <body xmlns="http://www.w3.org/1999/xhtml">
                <GENE ASSOCIATION: (((TTC1287 or TTC1286) and TTC1288) or ((TTC1628 or TTC1629) and TTC1627) or ((TTC0612 or TTC1629) and TTC1627) or ((TTC0612 or TTC1628) or TTC1628) or (TTC1628) or TTC1629) and TTC1627) or ((TTC0612 or TTC1628) or TTC1629) and TTC1627) or ((TTC0612 or TTC1628) or TTC1628) or ((TTC1628 or TTC1628) or (TTC1628) or (TTC1628) or (TTC1628) or (TTC1628) or TTC1628) or TTC1628) or TTC1628 or TTC1628) or TTC1628 or TTC1628 or TTC1628) or TTC1628 or
TTC0613) and TTC0615))
                SUBSYSTEM: Transport, Extracellular
                EC Number: 
                Confidence Level: 1
                AUTHORS: Transport
                </body>
          </notes>
          listOfReactants>
             <speciesReference species="M_ATP_c" stoichiometry="1"/>
```

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<speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M MALT e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_MALT_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 drameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R747" name="Isomaltose transport via ABC transporter" reversible="false">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Transport, Extracellular
   EC Number: 
   Confidence Level: 1
   AUTHORS: Transport
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</body>
   </notes>
   listOfReactants>
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     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_IMALT_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M H c" stoichiometry="1"/>
     <speciesReference species="M_IMALT_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R748" name="D-Mannose 1-phosphate transport" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
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GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
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 <speciesReference species="M_MAN1P_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_MAN1P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R749" name="D-Mannose 6-phosphate transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_M6P_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_M6P_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
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GENE_ASSOCIATION: ((TTC0326 or TTC0327) and TTC0328)
 SUBSYSTEM: Transport, Extracellular
 EC Number: 
 Confidence Level: 1
 AUTHORS: Transport
 </body>
</notes>
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<speciesReference species="M_ATP_c" stoichiometry="1"/>
<speciesReference species="M_H2O_c" stoichiometry="1"/>
<speciesReference species="M D MAN e" stoichiometry="1"/>
</listOfReactants>
distOfProducts>
<speciesReference species="M_ADP_c" stoichiometry="1"/>
<speciesReference species="M_Pi_c" stoichiometry="1"/>
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<speciesReference species="M_D_MAN_c" stoichiometry="1"/>
</listOfProducts>
<kineticLaw>
<math xmlns="http://www.w3.org/1998/Math/MathML">
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distOfParameters>
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 <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
 <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 <notes>
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
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 </listOfReactants>
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 <speciesReference species="M_L_PHE_c" stoichiometry="1"/>
 </listOfProducts>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
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</kineticLaw>
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<reaction id="R_R752" name="L-Proline transport" reversible="true">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_L_PRO_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 </listOfParameters>
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</kineticLaw>
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   SUBSYSTEM: Transport, Extracellular
   EC Number: 
   Confidence Level: 1
   AUTHORS: Transport
   </body>
 </notes>
 listOfReactants>
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 <speciesReference species="M_D_RIB_e" stoichiometry="1"/>
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 distOfProducts>
 <speciesReference species="M_H_c" stoichiometry="1"/>
 <speciesReference species="M_D_RIB_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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 listOfParameters>
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   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<reaction id="R_R754" name="D-Sorbitol transport" reversible="true">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_SORB_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<reaction id="R_R755" name="L-Serine transport" reversible="true">
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 <body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
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 </notes>
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 distOfProducts>
 <speciesReference species="M_L_SER_c" stoichiometry="1"/>
 </listOfProducts>
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 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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</reaction>
<reaction id="R_R756" name="Sulfite transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_SO3_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_SO3_c" stoichiometry="1"/>
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 listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R757" name="Succinate transport via proton symport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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   SUBSYSTEM: Transport, Extracellular
   EC Number: 
   Confidence Level: 1
   AUTHORS: Transport
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 </notes>
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 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_H_c" stoichiometry="2"/>
 <speciesReference species="M_SUCC_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 distOfParameters>
   <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
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             </listOfParameters>
           </kineticLaw>
        </reaction>
        <reaction id="R_R758" name="Sucrose transport via ABC transporter" reversible="false">
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TTC0613) and TTC0615))
                SUBSYSTEM: Transport, Extracellular
                EC Number: 
                Confidence Level: 1
                AUTHORS: Transport
                </body>
           </notes>
           IistOfReactants>
             <speciesReference species="M_ATP_c" stoichiometry="1"/>
             <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M_SUC_e" stoichiometry="1"/>
           </listOfReactants>
           listOfProducts>
             <speciesReference species="M_ADP_c" stoichiometry="1"/>
             <speciesReference species="M Pi c" stoichiometry="1"/>
             <speciesReference species="M_H_c" stoichiometry="1"/>
             <speciesReference species="M_SUC_c" stoichiometry="1"/>
           </listOfProducts>
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<parameter id="UPPER\_BOUND" value="1000" units="mmol\_per\_gDW\_per\_hr" constant="true"/>

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<kineticLaw>
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    distOfParameters>
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     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R759" name="L-Alanine transport via ABC system" reversible="false">
   <notes>
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TTC0969 or TTC0078)) and ((TTC0220 or TTC0337 or TTC0598 or TTC0967 or TTC0080) and (TTC216 or TTC0968 or
TTC0081))
     SUBSYSTEM: Transport, Extracellular
     EC Number: 
     Confidence Level: 1
     AUTHORS: Transport
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_ATP_c" stoichiometry="1"/>
    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_L_ALA_e" stoichiometry="1"/>
   </listOfReactants>
```

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distOfProducts>
 <speciesReference species="M_L_ALA_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
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 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R760" name="L-Aspartate transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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<speciesReference species="M_L_ASP_e" stoichiometry="1"/>
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 listOfProducts>
 <speciesReference species="M_L_ASP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R761" name="L-Cysteine transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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<speciesReference species="M_L_CYS_e" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_L_CYS_c" stoichiometry="1"/>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R762" name="L-Glutamate transport" reversible="true">
 <notes>
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  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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<speciesReference species="M_L_GLU_e" stoichiometry="1"/>
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 listOfProducts>
 <speciesReference species="M_L_GLU_c" stoichiometry="1"/>
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 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R763" name="L-Methionine transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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<speciesReference species="M_L_MET_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_MET_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R764" name="L-Threonine transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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<speciesReference species="M_L_THR_e" stoichiometry="1"/>
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          distOfProducts>
             <speciesReference species="M_L_THR_c" stoichiometry="1"/>
          <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
               <ci> FLUX_VALUE </ci>
             definition of the control of
                <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R_R765" name="L-Leucine transport via ABC system" reversible="false">
          <notes>
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TTC0969 or TTC0078)) and ((TTC0220 or TTC0337 or TTC0598 or TTC0967 or TTC0080) and (TTC216 or TTC0968 or
TTC0081))
                SUBSYSTEM: Transport, Extracellular
                EC Number: 
                Confidence Level: 1
                AUTHORS: Transport
                </body>
          </notes>
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listOfReactants>
 <speciesReference species="M_ATP_c" stoichiometry="1"/>
 <speciesReference species="M_H2O_c" stoichiometry="1"/>
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 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_LEU_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R766" name="L-Tryptophan transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
   GENE_ASSOCIATION: 
   SUBSYSTEM: Transport, Extracellular
   EC Number: 
   Confidence Level: 1
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AUTHORS: Transport
  </body>
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 listOfReactants>
 <speciesReference species="M_L_TRP_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_TRP_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R767" name="L-Tyrosine transport" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
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AUTHORS: Transport
     </body>
   </notes>
   listOfReactants>
    <speciesReference species="M_L_TYR_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_L_TYR_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
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    <listOfParameters>
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     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
    /listOfParameters>
   </kineticLaw>
  </reaction>
  <reaction id="R_R768" name="L-Valine transport via ABC system" reversible="false">
   <notes>
    <body xmlns="http://www.w3.org/1999/xhtml">
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TTC0969 or TTC0078)) and ((TTC0220 or TTC0337 or TTC0598 or TTC0967 or TTC0080) and (TTC216 or TTC0968 or
TTC0081))
     SUBSYSTEM: Transport, Extracellular
     EC Number:
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Confidence Level: 1
   AUTHORS: Transport
   </body>
 </notes>
 distOfReactants>
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 <speciesReference species="M_H2O_c" stoichiometry="1"/>
 <speciesReference species="M_L_VAL_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_L_VAL_c" stoichiometry="1"/>
 <speciesReference species="M_ADP_c" stoichiometry="1"/>
 <speciesReference species="M_Pi_c" stoichiometry="1"/>
 /listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R769" name="Bicarbonate transport" reversible="true">
 <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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 <speciesReference species="M_HCO3_c" stoichiometry="1"/>
 /listOfProducts>
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  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R R770" name="L-Lactate transport" reversible="true">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
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 distOfProducts>
 <speciesReference species="M_LAC_c" stoichiometry="1"/>
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 <kineticLaw>
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 <listOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R R771" name="Ammonia transport" reversible="true">
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  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
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 distOfProducts>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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</reaction>
<reaction id="R R772" name="Trehalose transport via ATP transporter" reversible="false">
 <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
                TTC0613) and TTC0615))
                SUBSYSTEM: Transport, Extracellular
                EC Number: 
                Confidence Level: 1
                AUTHORS: Transport
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             <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M_TRE_e" stoichiometry="1"/>
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             <speciesReference species="M_ADP_c" stoichiometry="1"/>
             <speciesReference species="M_Pi_c" stoichiometry="1"/>
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          </listOfProducts>
          <kineticLaw>
             <math xmlns="http://www.w3.org/1998/Math/MathML">
               <ci> FLUX_VALUE </ci>
             definition of the control of
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                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R773" name="Magnesium transport via diffusion" reversible="false">
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   SUBSYSTEM: Transport, Extracellular
   EC Number: 
   Confidence Level: 1
   AUTHORS: Transport
   </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_Mg_e" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_Mg_c" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
   <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
   <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
   <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R774" name="Heme export via diffusion" reversible="false">
 <notes>
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  GENE_ASSOCIATION: (TTC1401 and TTC1402)
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
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 distOfProducts>
 <speciesReference species="M_HEME_e" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 listOfParameters>
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  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R775" name="D-Gluconate transport" reversible="false">
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  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
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 listOfReactants>
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 distOfProducts>
 <speciesReference species="M_GLCN_c" stoichiometry="1"/>
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 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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           </kineticLaw>
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TTC0613) and TTC0615))
                 SUBSYSTEM: Transport, Extracellular
                 EC Number: 
                 Confidence Level: 1
                 AUTHORS: Transport
                 </body>
           </notes>
           listOfReactants>
              <speciesReference species="M_ATP_c" stoichiometry="1"/>
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              <speciesReference species="M_CELBS_e" stoichiometry="1"/>
           </listOfReactants>
           distOfProducts>
              <speciesReference species="M_ADP_c" stoichiometry="1"/>
              <speciesReference species="M_Pi_c" stoichiometry="1"/>
              <speciesReference species="M_H_c" stoichiometry="1"/>
              <speciesReference species="M CELBS c" stoichiometry="1"/>
           </listOfProducts>
           <kineticLaw>
              <math xmlns="http://www.w3.org/1998/Math/MathML">
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                <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
             /listOfParameters>
          </kineticLaw>
       </reaction>
       <reaction id="R R777" name="Palatinose transport via ABC system" reversible="false">
          <notes>
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TTC0613) and TTC0615))
                SUBSYSTEM: Transport, Extracellular
                EC Number: 
                Confidence Level: 1
                AUTHORS: Transport
                </body>
          </notes>
          listOfReactants>
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             <speciesReference species="M_H2O_c" stoichiometry="1"/>
             <speciesReference species="M PALT e" stoichiometry="1"/>
          </listOfReactants>
          distOfProducts>
             <speciesReference species="M_ADP_c" stoichiometry="1"/>
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<speciesReference species="M_Pi_c" stoichiometry="1"/>
     <speciesReference species="M H c" stoichiometry="1"/>
     <speciesReference species="M_PALT_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
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        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R778" name="D-Galactose transport via ABC system" reversible="false">
   <notes>
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        SUBSYSTEM: Transport, Extracellular
        EC Number: 
        Confidence Level: 1
        AUTHORS: Transport
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_ATP_c" stoichiometry="1"/>
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<speciesReference species="M_H2O_c" stoichiometry="1"/>
                    <speciesReference species="M D GAL e" stoichiometry="1"/>
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                distOfProducts>
                    <speciesReference species="M_ADP_c" stoichiometry="1"/>
                    <speciesReference species="M_Pi_c" stoichiometry="1"/>
                    <speciesReference species="M_H_c" stoichiometry="1"/>
                    <speciesReference species="M_D_GAL_c" stoichiometry="1"/>
                </listOfProducts>
                <kineticLaw>
                    <math xmlns="http://www.w3.org/1998/Math/MathML">
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                    definition of the control of
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                         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
                         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
                    </listOfParameters>
                </kineticLaw>
             </reaction>
            <reaction id="R_R779" name="Latose transport via ABC system" reversible="false">
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TTC0613) and TTC0615))
                         SUBSYSTEM: Transport, Extracellular
                         EC Number: 
                         Confidence Level: 1
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AUTHORS: Transport
        </body>
   </notes>
   listOfReactants>
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     <speciesReference species="M_H2O_c" stoichiometry="1"/>
     <speciesReference species="M_LACTS_e" stoichiometry="1"/>
   </listOfReactants>
   listOfProducts>
     <speciesReference species="M_ADP_c" stoichiometry="1"/>
     <speciesReference species="M Pi c" stoichiometry="1"/>
     <speciesReference species="M_H_c" stoichiometry="1"/>
     <speciesReference species="M_LACTS_c" stoichiometry="1"/>
   /listOfProducts>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
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        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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   </kineticLaw>
</reaction>
<reaction id="R R780" name="Stachyose transport via ABC system" reversible="false">
   <notes>
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     SUBSYSTEM: Transport, Extracellular
     EC Number: 
     Confidence Level: 1
     AUTHORS: Transport
     </body>
   </notes>
   listOfReactants>
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    <speciesReference species="M_H2O_c" stoichiometry="1"/>
    <speciesReference species="M_STCYS_e" stoichiometry="1"/>
   </listOfReactants>
   distOfProducts>
    <speciesReference species="M_ADP_c" stoichiometry="1"/>
    <speciesReference species="M_Pi_c" stoichiometry="1"/>
    <speciesReference species="M H c" stoichiometry="1"/>
    <speciesReference species="M_STCYS_c" stoichiometry="1"/>
   </listOfProducts>
   <kineticLaw>
    <math xmlns="http://www.w3.org/1998/Math/MathML">
     <ci> FLUX_VALUE </ci>
    distOfParameters>
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     <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
     <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R781" name="PHB transport" reversible="false">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
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 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PHB_e" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R782" name="PHV transport" reversible="false">
 <notes>
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  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_PHV_c" stoichiometry="1"/>
 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PHV_e" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R783" name="PHO transport" reversible="false">
 <notes>
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 listOfReactants>
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 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PHO_e" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R784" name="PHD transport" reversible="false">
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 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
 </notes>
 distOfReactants>
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 </listOfReactants>
 distOfProducts>
 <speciesReference species="M_PHD_e" stoichiometry="1"/>
 </listOfProducts>
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 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<reaction id="R_R785" name="PHDD transport" reversible="false">
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  SUBSYSTEM: Transport, Extracellular
  EC Number: 
  Confidence Level: 1
  AUTHORS: Transport
  </body>
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 distOfReactants>
 <speciesReference species="M_PHDD_c" stoichiometry="1"/>
 </listOfReactants>
 listOfProducts>
 <speciesReference species="M_PHDD_e" stoichiometry="1"/>
 </listOfProducts>
 <kineticLaw>
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  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R786" name="Glucose exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_D_GLC_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 IistOfParameters>
  <parameter id="LOWER_BOUND" value="-10" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
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</reaction>
<reaction id="R R787" name="Water exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H2O_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R788" name="Oxygen exchange" reversible="true">
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<body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
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 </notes>
 <speciesReference species="M_O2_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-10" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R789" name="Sulfate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
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EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_SO4_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R790" name="Phosphate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS:
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</body>
   </notes>
   listOfReactants>
      <speciesReference species="M_Pi_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R791" name="Carbon dioxide exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
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         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
         AUTHORS: 
         </body>
   </notes>
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listOfReactants>
 <speciesReference species="M_CO2_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R792" name="Acetate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_AC_e" stoichiometry="1"/>
 </listOfReactants>
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<kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
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         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R793" name="D-Alanyl-D-alanine exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
         AUTHORS: 
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_D_ALA_D_ALA_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
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distOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R794" name="L-Arginine exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_ARG_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R795" name="L-Asparagine exchange" reversible="true">
   <notes>
     <body xmlns="http://www.w3.org/1999/xhtml">
        GENE_ASSOCIATION: 
        SUBSYSTEM: Exchange Reactions
        EC Number: 
        Confidence Level: 1
        AUTHORS: 
        </body>
   </notes>
   listOfReactants>
     <speciesReference species="M L ASN e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
        <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R796" name="Citrate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CIT_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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<reaction id="R_R797" name="Ethanol exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_ETH_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R798" name="D-Fructose 1-phosphate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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GENE_ASSOCIATION: 
         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
         AUTHORS: 
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_F1P_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R799" name="L-Fuculose 1-phosphate exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Exchange Reactions
         EC Number:
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Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_FUCL1P_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R800" name="Ferrous ion exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS:
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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_Fe2_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R801" name="D-Fructose exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
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<speciesReference species="M_D_FRU_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R802" name="Fumarate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_FUM_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R803" name="alpha-D-Glucosamine 1-phosphate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_GLUCSA1P_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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<listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R804" name="D-Glucosamine 6-phosphate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GLUSAP_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R805" name="Glycolaldehyde exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GLYCALD_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
 /listOfParameters>
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```
</kineticLaw>
</reaction>
<reaction id="R_R806" name="D-Glutamate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_D_GLU_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R807" name="Glycolate exchange" reversible="true">
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<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_HY_AC_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R808" name="D-Glycerate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION:
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SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_D_GLCT_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R809" name="Glycerol exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
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AUTHORS: 
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 </listOfReactants>
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  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R810" name="Glycine exchange" reversible="true">
 <notes>
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  EC Number: 
  Confidence Level: 1
  AUTHORS: 
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</notes>
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         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R811" name="Hydrogen sulfide exchange" reversible="true">
   <notes>
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         EC Number: 
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</listOfReactants>
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 <listOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R812" name="L-Homocysteine exchange" reversible="true">
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  EC Number: 
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 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
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  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R813" name="L-Isoleucine tansport" reversible="true">
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  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R814" name="L-Lysine exchange" reversible="true">
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  EC Number: 
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  AUTHORS: 
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 <speciesReference species="M_L_LYS_e" stoichiometry="1"/>
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 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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</reaction>
<reaction id="R_R815" name="L-Malate exchange" reversible="true">
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         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
         AUTHORS: 
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   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
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         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
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</reaction>
<reaction id="R R816" name="Maltose exchange" reversible="true">
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  EC Number: 
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 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R817" name="Isomaltose exchange" reversible="true">
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 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
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  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R818" name="D-Mannose 1-phosphate exchange" reversible="true">
 <notes>
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EC Number: 
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   </notes>
   listOfReactants>
      <speciesReference species="M_MAN1P_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
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         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R819" name="D-Mannose 6-phosphate exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
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         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
         AUTHORS:
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</body>
   </notes>
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      <speciesReference species="M_M6P_e" stoichiometry="1"/>
   </listOfReactants>
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      <math xmlns="http://www.w3.org/1998/Math/MathML">
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      definition of the control of
          <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
          <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
          <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
          <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R820" name="D-Mannose exchange" reversible="true">
   <notes>
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          EC Number: 
          Confidence Level: 1
          AUTHORS: 
          </body>
   </notes>
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listOfReactants>
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 </listOfReactants>
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 <math xmlns="http://www.w3.org/1998/Math/MathML">
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 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R821" name="L-Phenylalanine exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 <speciesReference species="M_L_PHE_e" stoichiometry="1"/>
 </listOfReactants>
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<kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
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      definition of the control of
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         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R822" name="L-Proline exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
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         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
         AUTHORS: 
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_L_PRO_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
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distOfParameters>
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         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R823" name="D-Ribose exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
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         EC Number: 
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        AUTHORS: 
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   </notes>
   listOfReactants>
      <speciesReference species="M_D_RIB_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R_R824" name="D-Sorbitol exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Exchange Reactions
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  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M SORB e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R825" name="L-Serine exchange" reversible="true">
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  EC Number: 
  Confidence Level: 1
  AUTHORS: 
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 </notes>
 listOfReactants>
 <speciesReference species="M_L_SER_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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<reaction id="R_R826" name="Sulfite exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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  EC Number: 
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  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_SO3_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R827" name="Succinate exchange" reversible="true">
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 <body xmlns="http://www.w3.org/1999/xhtml">
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GENE_ASSOCIATION: 
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         EC Number: 
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         AUTHORS: 
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   </notes>
   listOfReactants>
      <speciesReference species="M_SUCC_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R828" name="Sucrose exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
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         SUBSYSTEM: Exchange Reactions
         EC Number:
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Confidence Level: 1
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 </notes>
 distOfReactants>
 <speciesReference species="M_SUC_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R829" name="L-Alanine exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS:
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</body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_ALA_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R830" name="L-Aspartate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
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<speciesReference species="M_L_ASP_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
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  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R831" name="L-Cysteine exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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  EC Number: 
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  AUTHORS: 
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 </notes>
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 <speciesReference species="M_L_CYS_e" stoichiometry="1"/>
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 <kineticLaw>
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<math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
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  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 </kineticLaw>
</reaction>
<reaction id="R R832" name="L-Glutamate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_GLU_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
```

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<listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R833" name="L-Methionine exchange" reversible="true">
 <notes>
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
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 <speciesReference species="M_L_MET_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     </listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R834" name="L-Threonine exchange" reversible="true">
   <notes>
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        SUBSYSTEM: Exchange Reactions
        EC Number: 
        Confidence Level: 1
        AUTHORS: 
        </body>
   </notes>
   distOfReactants>
     <speciesReference species="M_L_THR_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
     <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
     definition of the control of
        <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
        <parameter id="OBJECTIVE COEFFICIENT" value="0" units="mmol per gDW per hr" constant="true"/>
     </listOfParameters>
```

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</kineticLaw>
</reaction>
<reaction id="R_R835" name="L-Leucine exchange" reversible="true">
 <notes>
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_L_LEU_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R836" name="L-Tryptophan exchange" reversible="true">
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<notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_L_TRP_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER BOUND" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R837" name="L-Tyrosine exchange" reversible="true">
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SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
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 <speciesReference species="M_L_TYR_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R838" name="L-Valine exchange" reversible="true">
 <notes>
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
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AUTHORS: 
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 </notes>
 listOfReactants>
 <speciesReference species="M_L_VAL_e" stoichiometry="1"/>
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 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R839" name="Bicarbonate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
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</notes>
   distOfReactants>
      <speciesReference species="M_HCO3_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R840" name="L-Lactate exchange" reversible="true">
   <notes>
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         GENE_ASSOCIATION: 
         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
         AUTHORS: 
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_LAC_e" stoichiometry="1"/>
```

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</listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R841" name="Ammonia exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_NH4_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
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<ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R842" name="Trehalose exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_TRE_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
```

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<parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R843" name="Magnesium exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_Mg_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER BOUND" value="1000" units="mmol per gDW per hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R844" name="HEME exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
         AUTHORS: 
        </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_HEME_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      </listOfParameters>
   </kineticLaw>
```

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</reaction>
<reaction id="R R845" name="Gluconate exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_GLCN_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R R846" name="Cellobiose exchange" reversible="true">
 <notes>
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<body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_CELBS_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R847" name="Palatinose exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
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EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_PALT_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R848" name="D-Galactose exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS:
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</body>
   </notes>
   listOfReactants>
      <speciesReference species="M_D_GAL_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
          <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
          <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
          <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
          <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R R849" name="PHB exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
          SUBSYSTEM: Exchange Reactions
         EC Number: 
          Confidence Level: 1
          AUTHORS: 
          </body>
   </notes>
```

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listOfReactants>
 <speciesReference species="M PHB e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R850" name="PHV exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 <speciesReference species="M_PHV_e" stoichiometry="1"/>
 </listOfReactants>
```

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<kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R851" name="PHO exchange" reversible="true">
   <notes>
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         EC Number: 
         Confidence Level: 1
         AUTHORS: 
         </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_PHO_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
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distOfParameters>
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
         <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
      /listOfParameters>
   </kineticLaw>
</reaction>
<reaction id="R_R852" name="PHD exchange" reversible="true">
   <notes>
      <body xmlns="http://www.w3.org/1999/xhtml">
         GENE_ASSOCIATION: 
         SUBSYSTEM: Exchange Reactions
         EC Number: 
         Confidence Level: 1
        AUTHORS: 
        </body>
   </notes>
   listOfReactants>
      <speciesReference species="M_PHD_e" stoichiometry="1"/>
   </listOfReactants>
   <kineticLaw>
      <math xmlns="http://www.w3.org/1998/Math/MathML">
         <ci> FLUX_VALUE </ci>
      definition of the control of
         <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
```

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<parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 </listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R853" name="PHDD exchange" reversible="true">
 <notes>
 <body xmlns="http://www.w3.org/1999/xhtml">
  GENE_ASSOCIATION: 
  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M PHDD e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX VALUE" value="0" units="mmol per gDW per hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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/listOfParameters>
 </kineticLaw>
</reaction>
<reaction id="R_R854" name="H exchange" reversible="true">
 <notes>
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 listOfReactants>
 <speciesReference species="M_H_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 <listOfParameters>
  <parameter id="LOWER_BOUND" value="-1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="OBJECTIVE_COEFFICIENT" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
 /listOfParameters>
 </kineticLaw>
</reaction>
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<reaction id="R_R855" name="Lactose exchange" reversible="true">
 <notes>
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  SUBSYSTEM: Exchange Reactions
  EC Number: 
  Confidence Level: 1
  AUTHORS: 
  </body>
 </notes>
 distOfReactants>
 <speciesReference species="M_LACTS_e" stoichiometry="1"/>
 </listOfReactants>
 <kineticLaw>
 <math xmlns="http://www.w3.org/1998/Math/MathML">
  <ci> FLUX_VALUE </ci>
 distOfParameters>
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  <parameter id="UPPER_BOUND" value="1000" units="mmol_per_gDW_per_hr" constant="true"/>
  <parameter id="FLUX_VALUE" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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 <notes>
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                     SUBSYSTEM: Exchange Reactions
                    EC Number: 
                     Confidence Level: 1
                    AUTHORS: 
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                    <parameter id="LOWER_BOUND" value="0" units="mmol_per_gDW_per_hr" constant="true"/>
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              </kineticLaw>
          </reaction>
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   </model>
</sbml>
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