

[illegible]

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Dimensions[stoichiometryMatrix]

MatrixForm[stoichiometryMatrix, TableHeadings → {metaboliteIds, reactionIds}]

Out[503]= {80, 154}

Out[504]/MatrixForm=

	3-DEHYDROQUINATE-DEHYDRATASE-RXN\$r	ACALD\$r	ACALDt\$r	ACKr\$r	ACONTa\$r	1
2dda7p_c	0	0	0	0	0	
2ddg6p_c	0	0	0	0	0	
2dhg1cn_c	0	0	0	0	0	
34dhibz_c	0	0	0	0	0	
3dhq_c	1	0	0	0	0	
3dhs_k_c	-1	0	0	0	0	
3pg_c	0	0	0	0	0	
6p2dhg1cn_c	0	0	0	0	0	
6pgc_c	0	0	0	0	0	
ac_c	0	0	0	1	0	
acald_c	0	1	-1	0	0	
accoa_c	0	-1	0	0	0	
acon_c	0	0	0	0	-1	
actp_c	0	0	0	-1	0	
adp_c	0	0	0	-1	0	
akg_c	0	0	0	0	0	
amp_c	0	0	0	0	0	
atp_c	0	0	0	1	0	
catechol_c	0	0	0	0	0	
ccmuac_c	0	0	0	0	0	
cit_c	0	0	0	0	1	
co2_c	0	0	0	0	0	
coa_c	0	1	0	0	0	
dhap_c	0	0	0	0	0	
e4p_c	0	0	0	0	0	
etoh_c	0	0	0	0	0	
f6p_c	0	0	0	0	0	
fdp_c	0	0	0	0	0	
fum_c	0	0	0	0	0	
g3p_c	0	0	0	0	0	
g6p_c	0	0	0	0	0	
glc__D_c	0	0	0	0	0	
glcn_c	0	0	0	0	0	
gln__L_c	0	0	0	0	0	
glu__L_c	0	0	0	0	0	
glx_c	0	0	0	0	0	
glyc3p_c	0	0	0	0	0	
glyc_c	0	0	0	0	0	
h2o_c	-1	0	0	0	-1	
h_c	0	-1	0	0	0	
hco3_c	0	0	0	0	0	
icit_c	0	0	0	0	0	
lac__D_c	0	0	0	0	0	
mal__L_c	0	0	0	0	0	
nad_c	0	1	0	0	0	

nadh_c	0	-1	0	0	0
nadp_c	0	0	0	0	0
nadph_c	0	0	0	0	0
nh4_c	0	0	0	0	0
o2_c	0	0	0	0	0
oaa_c	0	0	0	0	0
pep_c	0	0	0	0	0
pi_c	0	0	0	0	0
pyr_c	0	0	0	0	0
q8_c	0	0	0	0	0
q8h2_c	0	0	0	0	0
r5p_c	0	0	0	0	0
ru5p__D_c	0	0	0	0	0
s7p_c	0	0	0	0	0
succ_c	0	0	0	0	0
xu5p__D_c	0	0	0	0	0
ac_e	0	0	0	0	0
acald_e	0	0	1	0	0
akg_e	0	0	0	0	0
co2_e	0	0	0	0	0
fum_e	0	0	0	0	0
glc__D_e	0	0	0	0	0
gln__L_e	0	0	0	0	0
glu__L_e	0	0	0	0	0
glyc_e	0	0	0	0	0
h2o_e	0	0	0	0	0
h_e	0	0	0	0	0
lac__D_e	0	0	0	0	0
mal__L_e	0	0	0	0	0
nh4_e	0	0	0	0	0
o2_e	0	0	0	0	0
pi_e	0	0	0	0	0
pyr_e	0	0	0	0	0
succ_e	0	0	0	0	0
toh_e	0	0	0	0	0

```
In[505]:= (* Print the "null space",
then replace values in the neighborhood of zero with zero. *)
Dimensions[intracellularNullspaceMatrix]
MatrixForm[intracellularNullspaceMatrix, TableHeadings → {reactionIds}]
MatrixForm[intracellularNullspaceMatrix /. x_ /; (Abs[x] ≤ tolerance) → 0,
TableHeadings → {reactionIds}]
```

Out[505]= {154, 98}

Out[506]/MatrixForm=

A very large output was generated. Here is a sample of it:

(<<1>>)

Show Less

Show More

Show Full Output

Set Size Limit...

Out[507]/MatrixForm=

3-DEHYDROQUINATE-DEHYDRATASE-RXN\$r	1	0	0	0	0	0
ACALD\$r	0	1	0	0	0	0
ACALDt\$r	0	0	1	0	0	0
ACKr\$r	0	0	0	1	0	0
ACONTa\$r	0	0	0	0	1	0
ACONTb\$r	0	0	0	0	0	1
ALCD2x\$r	0	0	0	0	0	0
ATPS4r\$r	0	0	0	0	0	0
CO2t\$r	0	0	0	0	0	0
CS\$r	0	0	0	0	0	0
DAHPSYN-RXN\$r	0	0	0	0	0	0
ENO\$r	0	0	0	0	0	0
ETOht2r\$r	0	0	0	0	0	0
EX_co2_e\$r	0	0	0	0	0	0
EX_glc_e\$r	0	0	0	0	0	0
EX_h2o_e\$r	0	0	0	0	0	0
EX_h_e\$r	0	0	0	0	0	0
EX_nh4_e\$r	0	0	0	0	0	0
EX_o2_e\$r	0	0	0	0	0	0
EX_pi_e\$r	0	0	0	0	0	0
FBA\$r	0	0	0	0	0	0
FRD7\$r	0	0	0	0	0	0
FUM\$r	0	0	0	0	0	0
GAPD\$r	0	0	0	0	0	0
GLUDy\$r	0	0	0	0	0	0
GLYCT\$r	0	0	0	0	0	0
H2Ot\$r	0	0	0	0	0	0
HCO3E\$r	0	0	0	0	0	0
ICDHyr\$r	0	0	0	0	0	0
ICL\$r	0	0	0	0	0	0
MDH\$r	0	0	0	0	0	0
NADTRHD\$r	0	0	0	0	0	0
NH4t\$r	0	0	0	0	0	0
O2t\$r	0	0	0	0	0	0
PDH\$r	0	0	0	0	0	0
PGI\$r	0	0	0	0	0	0
PGLCNDH\$r	0	0	0	0	0	0
PROTOCATECHUATE-DECARBOXYLASE-RXN\$r	0	0	0	0	0	0
PTAr\$r	0	0	0	0	0	0
PYRt2\$r	0	0	0	0	0	0
RPE\$r	0	0	0	0	0	0
RPI\$r	0	0	0	0	0	0
TALA\$r	0	0	0	0	0	0
TKT1\$r	0	0	0	0	0	0
TKT2\$r	0	0	0	0	0	0
TPI\$r	0	0	0	0	0	0
XYLA\$r	0	0	0	0	0	0
2DHGLCK\$f	0	0	0	0	0	0
3-DEHYDROQUINATE-DEHYDRATASE-RXN\$f	0	0	0	0	0	0
3-DEHYDROQUINATE-SYNTHASE-RXN\$f	-1.	0	0	0	0	0
3-DEHYDROQUINATE-SYNTHASE-RXN\$f	0	0	0	0	0	0

ACALD\$f	0	0	0	0	0	0
ACALDt\$f	0	0	0	0	0	0
ACKr\$f	0	0	0	0	0	0
ACONTa\$f	0	0	0	0	0	0
ACONTb\$f	0	0	0	0	-1.	1.
ACt2r\$f	0	0	0	-1.	0	0
ADK1\$f	0	0	0	0	0	0
AKGDH\$f	0	0	0	0	0	0
AKGt2r\$f	0	0	0	0	0	0
ALCD2x\$f	0	-1.	1.	0	0	0
ATPM\$f	0	0	0	0	0	0
ATPS4r\$f	0	0	0	0	0	0
Biomass_Ecoli_core_w_GAM\$f	0	0	0	0	0	0
CATECHOL-12-DIOXYGENASE-RXN\$f	-1.	0	0	0	0	0
CO2t\$f	0	0	0	0	0	0
CS\$f	0	0	0	0	-1.	0
CYTBD\$f	0	0	0	0	0	0
DAHPSYN-RXN\$f	-1.	0	0	0	0	0
DHSHIKIMATE-DEHYDRO-RXN\$f	-1.	0	0	0	0	0
D_LAcT2\$f	0	0	0	0	0	0
ENO\$f	0	0	0	0	0	0
ETOHt2r\$f	0	-1.	1.	0	0	0
EX_ac_e\$f	0	0	0	0	0	0
EX_acald_e\$f	0	0	0	0	0	0
EX_akg_e\$f	0	0	0	0	0	0
EX_co2_e\$f	0	0	0	0	0	0
EX_etoh_e\$f	0	0	0	0	0	0
EX_fum_e\$f	0	0	0	0	0	0
EX_glc_e\$f	0	0	0	0	0	0
EX_gln_L_e\$f	0	0	0	0	0	0
EX_glu_L_e\$f	0	0	0	0	0	0
EX_glyc_e\$f	0	0	0	0	0	0
EX_h2o_e\$f	0	0	0	0	0	0
EX_h_e\$f	0	0	0	0	0	0
EX_lac_D_e\$f	0	0	0	0	0	0
EX_mal_L_e\$f	0	0	0	0	0	0
EX_nh4_e\$f	0	0	0	0	0	0
EX_o2_e\$f	0	0	0	0	0	0
EX_pi_e\$f	0	0	0	0	0	0
EX_pyr_e\$f	0	0	0	0	0	0
EX_succ_e\$f	0	0	0	0	0	0
EX_xyl_e\$f	0	0	0	0	0	0
FBA\$f	0	0	0	0	0	0
FBP\$f	0	0	0	0	0	0
FRD7\$f	0	0	0	0	0	0
FUM\$f	0	0	0	0	0	0
FUMt2_2\$f	0	0	0	0	0	0
G3PD\$f	0	0	0	0	0	0
G6PDH2r\$f	0	0	0	0	0	0
GAPdH2r\$f	0	0	0	0	0	0

GADKtpp\$fr	0	0	0	0	0	0
GAPD\$f	0	0	0	0	0	0
GLCDpp\$f	0	0	0	0	0	0
GLCabcpp\$f	0	0	0	0	0	0
GLNS\$f	0	0	0	0	0	0
GLNabc\$f	0	0	0	0	0	0
GLUDy\$f	0	0	0	0	0	0
GLUN\$f	-1.	2.	-1.	0	1.	0
GLUSy\$f	1.	-2.	1.	0	-1.	0
GLUt2r\$f	-1.	2.	-1.	0	1.	0
GLYCT\$f	0	0	0	0	0	0
GLYK\$f	0	0	0	0	0	0
GND\$f	-0.5	0	0	0	0	0
GNK\$f	0	0	0	0	0	0
H2Ot\$f	-0.5	4.	-2.	1.	0	0
HCO3E\$f	0	0	0	0	0	0
HEX1\$f	0	0	0	0	0	0
ICDHyr\$f	1.	-2.	1.	0	-1.	0
ICL\$f	-1.	2.	-1.	0	0	0
KDPGALDOL\$f	-0.5	0	0	0	0	0
LDH_D\$f	0	0	0	0	0	0
MALS\$f	-1.	2.	-1.	0	0	0
MALt2_2\$f	2.5	-3.	1.	-1.	1.	0
MDH\$f	0	0	0	0	0	0
ME1\$f	0	0	0	0	0	0
ME2\$f	1.5	-1.	0	-1.	1.	0
NADH16\$f	0	0	0	0	0	0
NADTRHD\$f	0	0	0	0	0	0
NH4t\$f	1.	-2.	1.	0	-1.	0
O2t\$f	-1.	0	0	0	0	0
PC\$f	0	0	0	0	0	0
PDH\$f	-1.	3.	-1.	1.	-1.	0
PGI\$f	0	0	0	0	0	0
PGL\$f	-1.	0	0	0	0	0
PGLCNDH\$f	0	0	0	0	0	0
PGLUCONDEHYDRAT\$f	-0.5	0	0	0	0	0
PIt2r\$f	1.	0	0	0	0	0
PPC\$f	0	0	0	0	0	0
PPCK\$f	0	0	0	0	1.	0
PROTOCATECHUATE-DECARBOXYLASE-RXN\$f	-1.	0	0	0	0	0
PTAr\$f	0	0	0	1.	0	0
PYK\$f	1.	0	0	0	1.	0
PYRt2\$f	-3.	4.	-1.	2.	-3.	0
RPE\$f	0	0	0	0	0	0
RPI\$f	0.5	0	0	0	0	0
SUCct2_2\$f	1.66667	-2.	0.666667	-0.333333	0.333333	0
SUCct3\$f	0.666667	0	-0.333333	-0.333333	0.333333	0
TALA\$f	-0.5	0	0	0	0	0
THD2\$f	-1.	1.	0	1.	-1.	0
TKT1\$f	0.5	0	0	0	0	0
TKT2\$f	0.5	0	0	0	0	0

TPI\$f	0	0	0	0	0	0
XYLA\$f	0	0	0	0	0	0
XYL_ABC\$f	1.	0	0	1.	0	0
muconate_sink\$f	-1.	0	0	0	0	0

```
In[508]:= (* Print the application of the "null space" to the "whole" matrix,
then replace values in the neighborhood of zero with zero. *)
(* By definition, all elements of the block for
intracellular metabolites are in the neighborhood of zero. *)
Dimensions[stoichiometryMatrix.intracellularNullspaceMatrix]
MatrixForm[stoichiometryMatrix.intracellularNullspaceMatrix,
TableHeadings → {metaboliteIds}]
MatrixForm[stoichiometryMatrix.intracellularNullspaceMatrix /.
x_ /; (Abs[x] ≤ tolerance) → 0, TableHeadings → {metaboliteIds}]
```

```
Out[508]:= {80, 98}
```

```
Out[509]/MatrixForm=
```

2dda7p_c	1.9984×10^{-15}	-4.11206×10^{-16}	2.6786×10^{-16}	7.8217×10^{-17}	-5.16358×10^{-17}
2ddg6p_c	-1.22125×10^{-15}	1.55769×10^{-15}	-4.09496×10^{-16}	1.06699×10^{-15}	-5.20446×10^{-16}
2dhg1cn_c	-5.18696×10^{-16}	-1.87398×10^{-16}	-3.65368×10^{-16}	6.26584×10^{-17}	-2.16686×10^{-16}
34dhibz_c	-1.11022×10^{-16}	-1.08677×10^{-15}	7.8208×10^{-16}	8.37876×10^{-16}	-8.4968×10^{-16}
3dhq_c	0.	-5.1384×10^{-17}	-9.84386×10^{-17}	-3.93248×10^{-17}	-2.56873×10^{-17}
3dhsk_c	0.	2.20899×10^{-16}	-1.54999×10^{-16}	-6.00843×10^{-17}	3.7753×10^{-17}
3pg_c	6.56802×10^{-17}	-9.77234×10^{-16}	4.15646×10^{-16}	-1.97016×10^{-19}	3.50899×10^{-16}
6p2dhg1cn_c	6.5236×10^{-16}	-2.12981×10^{-16}	3.28551×10^{-16}	-9.37632×10^{-17}	4.67058×10^{-16}
6pgc_c	1.22125×10^{-15}	1.08812×10^{-16}	2.79236×10^{-16}	-7.35375×10^{-16}	-8.85166×10^{-16}
ac_c	-7.51485×10^{-17}	3.3709×10^{-16}	-1.80935×10^{-16}	-2.22045×10^{-16}	1.91545×10^{-16}
acald_c	7.67209×10^{-16}	0.	-7.77156×10^{-16}	-5.51852×10^{-16}	2.12045×10^{-16}
accoa_c	-2.24927×10^{-15}	2.06614×10^{-15}	-1.08166×10^{-15}	1.11022×10^{-15}	-1.07796×10^{-15}
acon_c	-2.49228×10^{-16}	-6.57715×10^{-16}	6.6446×10^{-16}	2.35949×10^{-16}	-1.11022×10^{-16}
actp_c	-5.26283×10^{-16}	1.54303×10^{-16}	3.04506×10^{-16}	6.66134×10^{-16}	-1.36453×10^{-16}
adp_c	-1.22125×10^{-15}	2.13996×10^{-14}	-1.30624×10^{-14}	-1.66533×10^{-15}	1.70981×10^{-15}
akg_c	-6.66134×10^{-16}	0.	-2.22045×10^{-16}	-4.84286×10^{-16}	-1.9984×10^{-16}
amp_c	-2.05662×10^{-16}	-1.24449×10^{-15}	3.34072×10^{-16}	-5.42262×10^{-16}	-4.15022×10^{-16}
atp_c	1.44329×10^{-15}	-2.01551×10^{-14}	1.27284×10^{-14}	2.10942×10^{-15}	-1.66541×10^{-15}
catechol_c	3.33067×10^{-16}	6.95499×10^{-16}	-7.68698×10^{-16}	-5.40677×10^{-16}	1.55725×10^{-16}
ccmuac_c	-3.33067×10^{-16}	1.02776×10^{-16}	4.2365×10^{-16}	5.45329×10^{-16}	-1.43541×10^{-16}
cit_c	-1.65232×10^{-16}	1.62972×10^{-16}	-3.64328×10^{-16}	-2.29411×10^{-16}	2.22045×10^{-16}
co2_c	-3.55271×10^{-15}	4.49792×10^{-15}	-2.27357×10^{-15}	1.01076×10^{-15}	-2.19239×10^{-15}
coa_c	2.24927×10^{-15}	-2.06614×10^{-15}	1.08166×10^{-15}	-1.11022×10^{-15}	1.07796×10^{-15}
dhap_c	-1.65942×10^{-15}	2.12708×10^{-15}	-9.92501×10^{-16}	4.15736×10^{-16}	-1.47519×10^{-15}
e4p_c	-1.44329×10^{-15}	5.64058×10^{-16}	-2.77219×10^{-16}	-4.82228×10^{-16}	1.36935×10^{-16}
etoh_c	-2.75392×10^{-16}	0.	3.33067×10^{-16}	8.28166×10^{-16}	-6.88041×10^{-16}
f6p_c	-8.88178×10^{-16}	-9.05573×10^{-16}	2.55881×10^{-16}	6.54574×10^{-16}	4.32663×10^{-16}
fdp_c	8.30761×10^{-16}	-6.57715×10^{-16}	1.47658×10^{-16}	-7.86496×10^{-16}	-6.32302×10^{-16}
f6p_c	1.66551×10^{-15}	4.11206×10^{-16}	2.6786×10^{-16}	7.8217×10^{-17}	-5.16358×10^{-17}

rum_c	1.60051×10^{-16}	-4.11072×10^{-16}	-2.46096×10^{-16}	-7.86496×10^{-17}	1.24485
g3p_c	4.38174×10^{-16}	-1.53486×10^{-15}	3.15094×10^{-16}	-2.3974×10^{-16}	-6.29738
g6p_c	8.79931×10^{-16}	-5.42866×10^{-16}	-1.11497×10^{-16}	-3.5449×10^{-17}	2.42854
glc__D_c	-6.89416×10^{-16}	1.9616×10^{-17}	2.82043×10^{-16}	2.59081×10^{-16}	-9.91685
glcn_c	1.11863×10^{-16}	-3.52174×10^{-16}	9.68155×10^{-17}	-3.19568×10^{-16}	6.40186
gln__L_c	1.33227×10^{-15}	-1.77636×10^{-15}	5.55112×10^{-16}	-4.71897×10^{-16}	0.
glu__L_c	1.11022×10^{-16}	8.88178×10^{-16}	0.	4.96617×10^{-16}	-4.44089
glx_c	-7.77156×10^{-16}	4.44089×10^{-16}	-3.33067×10^{-16}	-4.40024×10^{-17}	2.97505
glyc3p_c	8.96662×10^{-16}	-5.70334×10^{-16}	3.54564×10^{-16}	-5.44785×10^{-16}	-1.11361
glyc_c	-5.24277×10^{-16}	7.05381×10^{-16}	-4.22114×10^{-16}	5.89322×10^{-16}	1.22893
h2o_c	-4.77396×10^{-15}	-1.82826×10^{-14}	1.14018×10^{-14}	4.10783×10^{-15}	-1.65473
h_c	-7.66054×10^{-15}	2.28361×10^{-14}	-1.26674×10^{-14}	-4.32987×10^{-15}	9.43761
hco3_c	-1.66152×10^{-16}	8.22144×10^{-17}	2.70706×10^{-16}	3.34261×10^{-16}	-6.32302
icit_c	2.88658×10^{-15}	-1.55431×10^{-15}	3.33067×10^{-16}	-6.63862×10^{-16}	1.20119
lac__D_c	9.08673×10^{-17}	-2.53594×10^{-16}	1.464×10^{-16}	6.72415×10^{-17}	-3.0875
mal__L_c	2.22045×10^{-16}	8.88178×10^{-16}	2.19813×10^{-16}	4.44089×10^{-16}	-1.33227
nad_c	3.10862×10^{-15}	-5.21805×10^{-15}	2.44156×10^{-15}	-5.55112×10^{-16}	-1.11022
nadh_c	-3.10862×10^{-15}	5.21805×10^{-15}	-2.44156×10^{-15}	5.55112×10^{-16}	1.11022
nadp_c	-1.11022×10^{-15}	6.32827×10^{-15}	-3.66052×10^{-15}	7.77156×10^{-16}	3.9968
nadph_c	1.11022×10^{-15}	-6.32827×10^{-15}	3.66052×10^{-15}	-7.77156×10^{-16}	-3.9968
nh4_c	2.22045×10^{-16}	-8.88178×10^{-16}	0.	-2.08202×10^{-16}	-6.66134
o2_c	0.	1.60959×10^{-15}	-9.74478×10^{-16}	-5.78918×10^{-16}	1.06674
oaa_c	-6.24194×10^{-16}	1.00774×10^{-15}	-3.62505×10^{-17}	8.82159×10^{-16}	-2.22045
pep_c	-6.66134×10^{-16}	-3.10756×10^{-16}	-1.62598×10^{-16}	-6.96556×10^{-16}	8.88178
pi_c	-2.10942×10^{-15}	1.91294×10^{-14}	-1.23155×10^{-14}	-3.88578×10^{-15}	1.63753
pyr_c	-4.44089×10^{-16}	-3.55271×10^{-15}	2.44249×10^{-15}	-1.33227×10^{-15}	-8.88178
q8_c	-1.1049×10^{-15}	3.63586×10^{-16}	6.1929×10^{-16}	1.02957×10^{-15}	-6.71445
q8h2_c	1.1049×10^{-15}	-3.63586×10^{-16}	-6.1929×10^{-16}	-1.02957×10^{-15}	6.71445
r5p_c	5.55112×10^{-16}	-1.17261×10^{-15}	4.17771×10^{-16}	-1.34434×10^{-16}	-1.66931
ru5p__D_c	-1.11022×10^{-16}	1.69655×10^{-15}	-6.26305×10^{-16}	4.86794×10^{-16}	-2.63944
s7p_c	-3.33067×10^{-16}	2.33192×10^{-16}	5.2225×10^{-17}	1.34611×10^{-16}	-4.92594
succ_c	4.44089×10^{-16}	-1.47225×10^{-15}	1.94289×10^{-15}	-5.55112×10^{-17}	7.21645
xu5p__D_c	4.44089×10^{-16}	-4.47098×10^{-17}	1.66808×10^{-16}	-1.69908×10^{-16}	6.195
ac_e	7.51485×10^{-17}	-3.3709×10^{-16}	1.80935×10^{-16}	1.	-1.91545
acald_e	0.	0.	1.	0.	0.
akg_e	0.	0.	0.	0.	0.
co2_e	0.	0.	0.	0.	0.
fum_e	-1.60051×10^{-15}	4.11072×10^{-16}	2.46096×10^{-16}	7.86496×10^{-17}	-1.24485
glc__D_e	0.	0.	0.	0.	0.
gln__L_e	0.	0.	0.	0.	0.
glu__L_e	1.	-2.	1.	3.33755×10^{-15}	-1
glyc_e	-3.72385×10^{-16}	-1.35047×10^{-16}	6.75507×10^{-17}	-4.45367×10^{-17}	-1.15314
h2o_e	0.5	4	2	1	2.56641

h2o_e	0.	-4.	2.	-1.	-2.50041
h_e	-4.	2.	-1.	1.	-1
lac__D_e	0.	0.	0.	0.	0.
mal__L_e	-2.5	3.	-1.	1.	-1
nh4_e	-1.	2.	-1.	-2.68217×10^{-15}	1.
o2_e	1.	-1.77996×10^{-15}	8.3286×10^{-16}	8.16033×10^{-16}	1.83575
pi_e	-1.	5.94371×10^{-16}	-8.07814×10^{-16}	2.35488×10^{-15}	1.30489
pyr_e	3.	-4.	1.	-2.	3.
succ_e	-1.	2.	-1.	-2.38698×10^{-15}	1.66533
toh_e	-4.91817×10^{-16}	1.	-1.	-2.76314×10^{-16}	4.75996

Out[510]//MatrixForm=

[illegible]

h2o_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
h_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hco3_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
icit_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lac__D_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mal__L_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nad_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nadh_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nadp_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nadph_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nh4_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
o2_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
oaa_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pep_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pi_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pyr_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
q8_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
q8h2_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
r5p_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ru5p__D_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
s7p_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
succ_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
xu5p__D_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ac_e	0	0	0	1.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
acald_e	0	0	1.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
akg_e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
co2_e	0	0	0	0	0	0	0	0	1.	0	0	0	0	1.	0	0	0	0	0
fum_e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
glc__D_e	0	0	0	0	0	0	0	0	0	0	0	0	0	1.	0	0	0	0	0
gln__L_e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
glu__L_e	1.	-2.	1.	0	-1.	0	0	0	1.	0	0	-1.	0	0	0	0	0	0	0
glyc_e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
h2o_e	0.5	-4.	2.	-1.	0	0	0	0	2.	0	0	-1.	0	0	0	1.	0	0	0
h_e	-4.	2.	-1.	1.	-1.	0	0	0	-2.	0	0	-1.	0	0	0	0	1.	0	0
lac__D_e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mal__L_e	-2.5	3.	-1.	1.	-1.	0	0	0	-2.	0	0	1.	0	0	0	0	0	0	0
nh4_e	-1.	2.	-1.	0	1.	0	0	0	-1.	0	0	1.	0	0	0	0	0	1.	0
o2_e	1.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.	0
pi_e	-1.	0	0	0	0	0	0	0	0	0	-1.	0	0	0	0	0	0	0	1.
pyr_e	3.	-4.	1.	-2.	3.	0	0	0	2.	0	0	-3.	0	0	0	0	0	0	0
succ_e	-1.	2.	-1.	0	0	0	0	0	-1.	0	0	1.	0	0	0	0	0	0	0
toh_e	0	1.	-1.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

```

In[512]:= Dimensions[extracellularStoichiometryMatrix.intracellularNullspaceMatrix]
MatrixForm[extracellularStoichiometryMatrix.intracellularNullspaceMatrix,
TableHeadings → {extracellularMetaboliteIds}]
MatrixForm[extracellularStoichiometryMatrix.intracellularNullspaceMatrix /.
x_ /; (Abs[x] ≤ tolerance) → 0, TableHeadings → {extracellularMetaboliteIds}]

```

```
Out[512]:= {19, 98}
```

