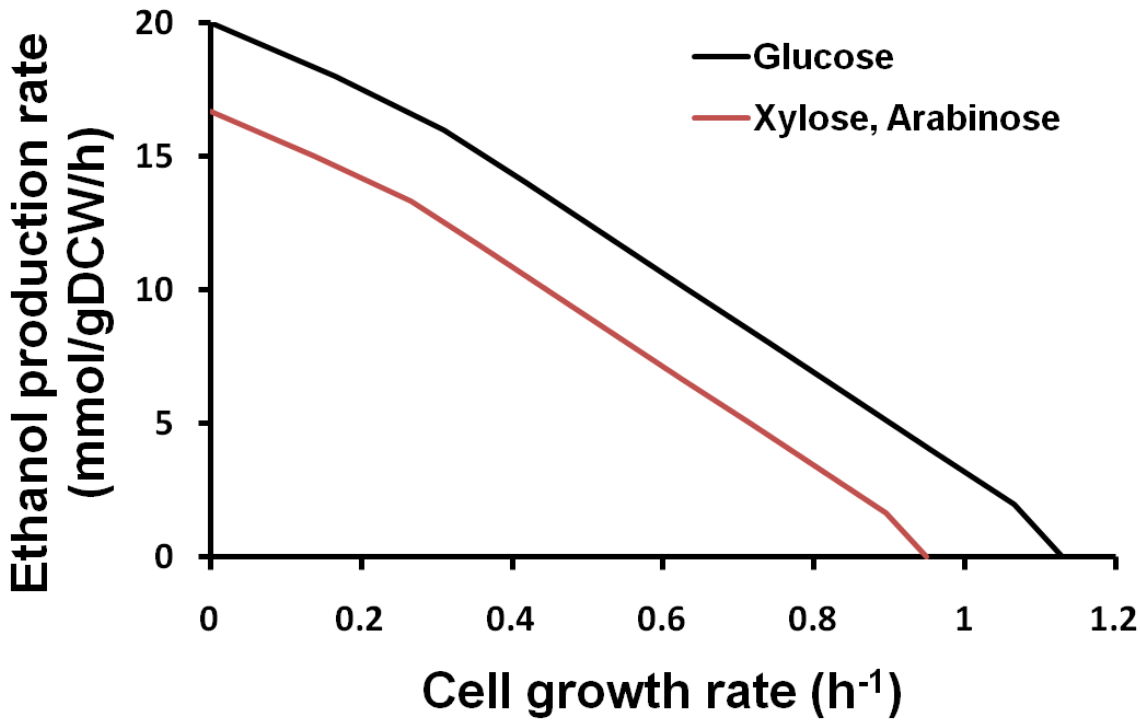
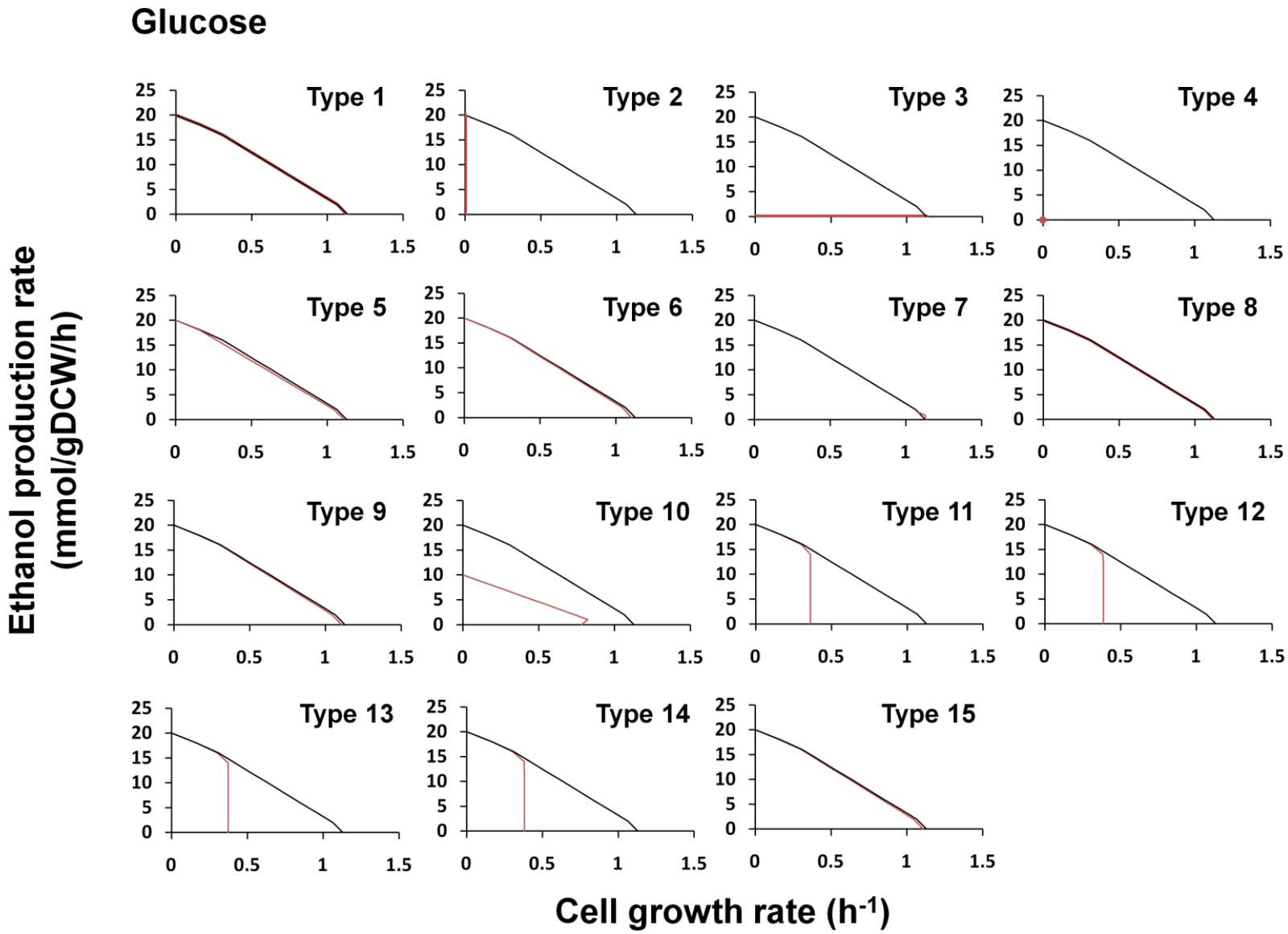
Additional file 5. Trade-off curves of (A) engineered strain of *Zymomonas mobilis* for the utilization of xylose and arabinose and (B) single gene knock out mutants based on the engineered strain for glucose, xylose, and arabinose as a carbon source. Uptake rate of each carbon source is fixed to 10 mmol/gDCW/h, and reaction for oxygen uptaking was deleted to describe anaerobic condition. NGAME (i.e. non-growth associated maintenance energy) value was eliminated

Additional figure 5 (A). Trade-off curves of engineered strain of *Z. mobilis* for glucose, xylose, and arabinose as a carbon source.



Additional figure 5 (B). Trade-off curves of single gene knockout mutants based on the engineered strain of *Z. mobilis* for glucose, xylose, and arabinose as a carbon source. The black and red lines indicate the trade-off curves of the engineered strain of *Z. mobilis* and the mutants by the deletion of each reaction in central metabolism listed below for each carbon source, respectively.



Type 1: R001, R002, R003, R004, R005, R006, R007, R021, R025, R027, R029, R030, R041, R042, R043, R044, R049, R050, R051, R053, R056, R057, R058, R060, R061, R062, R047, R048

Type 2: R008, R009, R010, R011, R012, R020, R022, R024, R028, R039, R040, R052, R055, R045, R046

Type 3: R019

Type 4: R033, R035

Type 5: R013

Type 6: R014, R015, R016, R017

Type 7: R018

Type 8: R023

Type 9: R026

Type 10: R031, R032

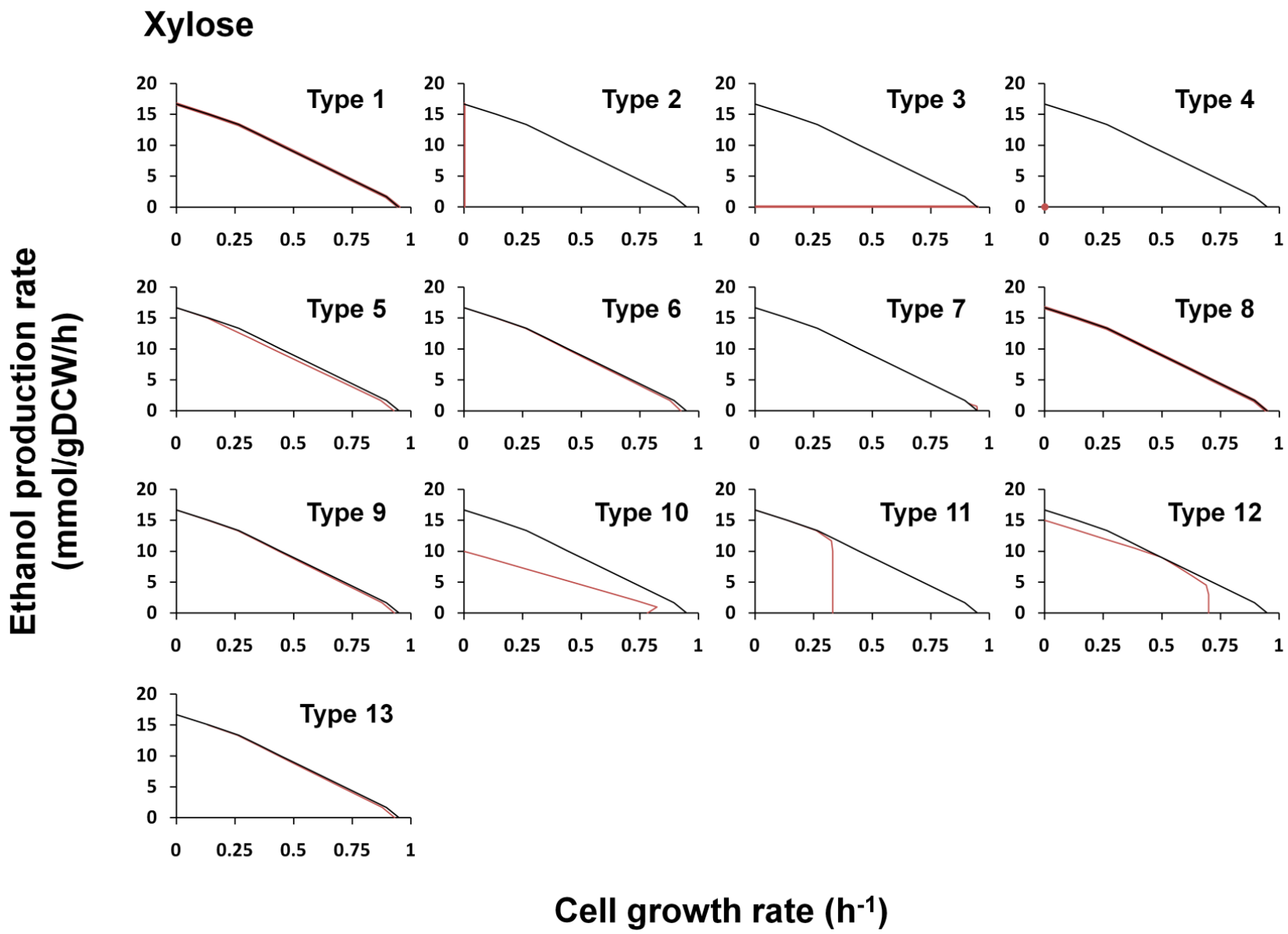
Type 11: R034

Type 12: R036

Type 13: R037, R059

Type 14: R038

Type 15: R054


Xylose
Type 1
Type 2
Type 3
Type 4
Type 5
Type 6
Type 7
Type 8
Type 9
Type 10
Type 11
Type 12
Type 13
Ethanol production rate (mmol/gDCW/h)
Cell growth rate (h-1)
0
5
10
15
20
0
0.25
0.5
0.75
1

Type 1: R001, R002, R003, R004, R005, R006, R007, R021, R025, R027, R029, R030, R041, R042, R043, R044, R049, R050, R051, R053, R056, R060, R061, R062, R047, R048

Type 2: R008, R009, R010, R011, R012, R020, R022, R024, R028, R040, R052, R055, R045, R046

Type 3: R019

Type 4: R033, R035, R036, R037, R039, R057, R058, R059

Type 5: R013

Type 6: R014, R015, R016, R017

Type 7: R018

Type 8: R023

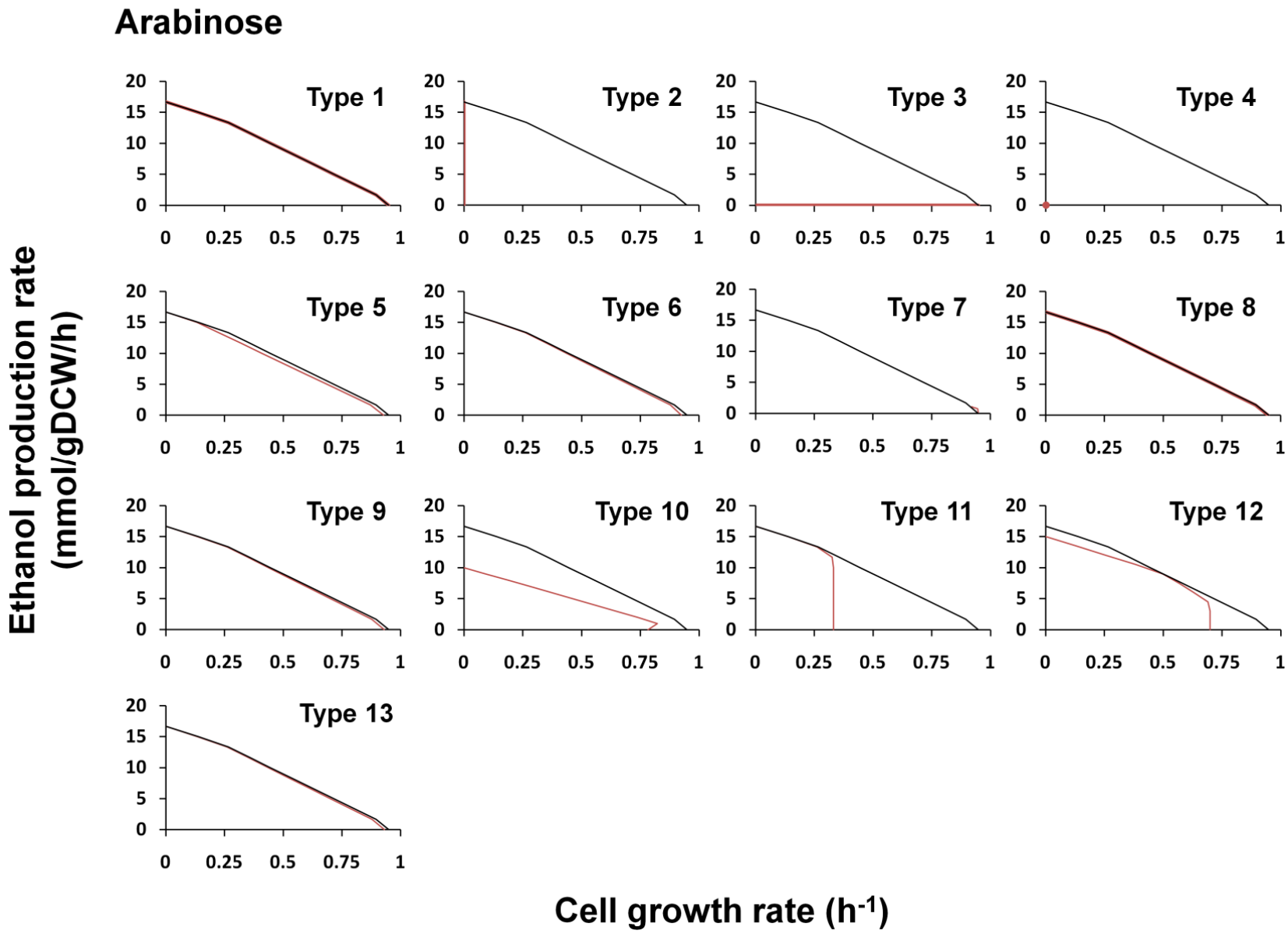
Type 9: R026

Type 10: R031, R032

Type 11: R034

Type 12: R038

Type 13: R054


Arabinose
Type 1
Type 2
Type 3
Type 4
Type 5
Type 6
Type 7
Type 8
Type 9
Type 10
Type 11
Type 12
Type 13
Ethanol production rate (mmol/gDCW/h)
Cell growth rate (h-1)
0
5
10
15
20
0
0.25
0.5
0.75
1

Type 1: R001, R002, R003, R004, R005, R006, R007, R021, R025, R027, R029, R030, R041, R042, R043, R044, R049, R050, R051, R053, R056, R057, R058, R047, R048

Type 2: R008, R009, R010, R011, R012, R020, R022, R024, R028, R040, R052, R055, R045, R046

Type 3: R019

Type 4: R033, R035, R036, R037, R039, R059, R060, R061, R062

Type 5: R013

Type 6: R014, R015, R016, R017

Type 7: R018

Type 8: R023

Type 9: R026

Type 10: R031, R032

Type 11: R034

Type 12: R038

Type 13: R054

A list of reactions used in additional figure 5 (B) for the simulation of single gene knockout. Information of each reaction below is available in additional file 1 and 2.

R001: G6P <-> bDG6P (5.3.1.9)

R002: G6P <-> F6P (5.3.1.9)

R003: bDG6P <-> F6P (5.3.1.9)

R004: GLC + ATP -> G6P + ADP (2.7.1.2)

R005: bDGLC <-> GLC (5.1.3.3)

R006: FDP -> F6P + PI (3.1.3.11)

R007: FDP <-> T3P1 + T3P2 (4.1.2.13)

R008: T3P1 <-> T3P2 (5.3.1.1)

R009: T3P1 + PI + NAD <-> NADH + 13DPG (1.2.1.12)

R010: 13DPG + ADP <-> 3PG + ATP (2.7.2.3)

R011: 3PG <-> 2PG (5.4.2.1)

R012: 2PG <-> PEP (4.2.1.11)

R013: PEP + ADP -> PYR + ATP (2.7.1.40)

R014: PYR + THPP -> 2HETHPP + CO2 (1.2.4.1)

R015: 2HETHPP + LIPO -> ADLIPO + THPP (1.2.4.1)

R016: COA + ADLIPO -> DLIPO + ACCOA (2.3.1.12)

R017: DLIPO + NAD -> LIPO + NADH (1.8.1.4)

R018: PYR -> ACAL + CO2 (4.1.1.1)

R019: ACAL + NADH <-> ETH + NAD (1.1.1.1)

R020: G6P <-> G1P (5.4.2.2)

R021: bDGLC + ATP -> bDG6P + ADP (2.7.1.2)

R022: ACCOA + OA -> COA + CIT (2.3.3.1)

R023: CIT <-> AC + OA (4.1.3.6)

R024: CIT <-> ICIT (4.2.1.3)

R025: ICIT + NADP <-> CO2 + NADPH + AKG (1.1.1.42)

R026: FUM <-> MAL (4.2.1.2)

R027: FUM + FADH2 <-> SUCC + FAD (1.3.99.1)

R028: SUCCOA + ADP + PI <-> ATP + COA + SUCC (6.2.1.5)

R029: GLCNDL -> GLCN (3.1.1.17)

R030: ATP + GLCN -> ADP + D6PGC (2.7.1.12)

R031: 2KD6PG -> T3P1 + PYR (4.1.2.14)

R032: D6PGC -> 2KD6PG (4.2.1.12)

R033: D6PGL -> D6PGC (3.1.1.31)

R034: D6PGC + NADP -> NADPH + CO2 + RL5P (1.1.1.44)

R035: bDG6P + NADP <-> D6PGL + NADPH (1.1.1.49)

R036: X5P + E4P <-> F6P + T3P1 (2.2.1.1)

R037: R5P + X5P <-> T3P1 + S7P (2.2.1.1)

R038: RL5P <-> X5P (5.1.3.1)

R039: RL5P <-> R5P (5.3.1.6)

R040: R5P <-> R1P (5.4.2.2)

R041: GLUC + NADP <-> 2kGLUC + NADPH (1.1.1.215)

R042: SUC -> GLC + LEVAN (2.4.1.10)

R043: SUC -> FRU + GLC (3.2.1.26)

R044: ATP + FRU <-> ADP + F6P (2.7.1.4)

R045: ATP + G1P -> ADPGLC + PPI (2.7.7.27)

R046: ADPGLC -> ADP + GLYCOGEN (2.4.1.21)

R047: GLYCOGEN + PI -> G1P (2.4.1.1)

R048: SUC6P -> FRU + G6P (3.2.1.26)

R049: RGT + MTGYX <-> SLGT (4.4.1.5)

R050: SLGT <-> RGT + LAC (3.1.2.6)

R051: PYR + NADH <-> NAD + LAC (1.1.1.28)

R052: PEP + CO2 -> OA + PI (4.1.1.31)

R053: PYR + COA -> ACCOA + FORT (2.3.1.54)

R054: MAL + NAD <-> CO2 + NADH + PYR (1.1.1.38)

R055: ACCOA + ATP + CO2 -> MALCOA + ADP + PI (6.4.1.2)

R056: NDP + PEP -> NTP + PYR (2.7.1.40)

R057: XYL <-> XYLU (5.3.1.5)

R058: ATP + XYLU <-> ADP + X5P (2.7.1.17)

R059: S7P + T3P1 <-> E4P + F6P (2.2.1.2)

R060: ARA <-> RIB (5.3.1.4)

R061: ATP + RIB <-> ADP + LRL5P (2.7.1.16)

R062: LRL5P <-> X5P (5.1.3.4)