**Table S1. Metabolic network model of *E. coli* used for 13C metabolic flux analysis**

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| **Glycolysis** | |
| v1 | Gluc.ext (abcdef) + PEP (ghi) → G6P (abcdef) + Pyr (ghi) |
| v2 | G6P (abcdef) ↔ F6P (abcdef) |
| v3 | F6P (abcdef) + ATP → FBP (abcdef) |
| v4 | FBP (abcdef) ↔ DHAP (cba) + GAP (def) |
| v5 | DHAP (abc) ↔ GAP (abc) |
| v6 | GAP (abc) ↔ 3PG (abc) + ATP + NADH |
| v7 | 3PG (abc) ↔ PEP (abc) |
| v8 | PEP (abc) → Pyr (abc) + ATP |
|  | |
| **Pentose Phosphate Pathway** | |
| v9 | G6P (abcdef) → 6PG (abcdef) + NADPH |
| v10 | 6PG (abcdef) → Ru5P (bcdef) + CO2 (a) + NADPH |
| v11 | Ru5P (abcde) ↔ X5P (abcde) |
| v12 | Ru5P (abcde) ↔ R5P (abcde) |
| v13 | X5P (abcde) ↔ TK-C2 (ab) + GAP (cde) |
| v14 | F6P (abcdef) ↔ TK-C2 (ab) + E4P (cdef) |
| v15 | S7P (abcdefg) ↔ TK-C2 (ab) + R5P (cdefg) |
| v16 | F6P (abcdef) ↔ TA-C3 (abc) + GAP (def) |
| v17 | S7P (abcdefg) ↔ TA-C3 (abc) + E4P (defg) |
|  | |
| **Entner-Doudoroff Pathway** | |
| v18 | 6PG (abcdef) → KDPG (abcdef) |
| v19 | KDPG (abcdef) → Pyr (abc) + GAP (def) |
|  | |
| **TCA Cycle** | |
| v20 | Pyr (abc) → AcCoA (bc) + CO2 (a) + NADH |
| v21 | OAC (abcd) + AcCoA (ef) → Cit (dcbfea) |
| v22 | Cit (abcdef) ↔ ICit (abcdef) |
| v23 | ICit (abcdef) ↔ AKG (abcde) + CO2 (f) + NADPH |
| v24 | AKG (abcde) → SucCoA (bcde) + CO2 (a) + NADH |
| v25 | SucCoA (abcd) ↔ Suc (½ abcd + ½ dcba) + ATP |
| v26 | Suc (½ abcd + ½ dcba) ↔ Fum (½ abcd + ½ dcba) + FADH2 |
| v27 | Fum (½ abcd + ½ dcba) ↔ Mal (abcd) |
| v28 | Mal (abcd) ↔ OAC (abcd) + NADH |
|  | |
| **Glyoxylate Shunt** | |
| v29 | ICit (abcdef) ↔ Glyox (ab) + Suc (½ edcf + ½ fcde) |
| v30 | Glyox (ab) + AcCoA (cd) → Mal (abdc) |
|  | |
| **Amphibolic Reactions** | |
| v31 | Mal (abcd) → Pyr (abc) + CO2 (d) + NADPH |
| v32 | Mal (abcd) → Pyr (abc) + CO2 (d) + NADH |
| v33 | PEP (abc) + CO2 (d) → OAC (abcd) |
| v34 | OAC (abcd) + ATP → PEP (abc) + CO2 (d) |
|  | |
| **Acetic Acid Formation** | |
| v35 | AcCoA (ab) ↔ Ac (ab) + ATP |
|  | |
| **Amino Acid Biosynthesis** | |
| v36 | AKG (abcde) + NADPH + NH3 → Glu (abcde) |
| v37 | Glu (abcde) + ATP + NH3 → Gln (abcde) |
| v38 | Glu (abcde) + ATP + 2 NADPH → Pro (abcde) |
| v39 | Glu (abcde) + CO2 (f) + Gln (ghijk) + Asp (lmno) + AcCoA (pq) + 5 ATP + NADPH →  Arg (abcdef) + AKG (ghijk) + Fum (lmno) + Ac (pq) |
| v40 | OAC (abcd) + Glu (efghi) → Asp (abcd) + AKG (efghi) |
| v41 | Asp (abcd) + 2 ATP + NH3 → Asn (abcd) |
| v42 | Pyr (abc) + Glu (defgh) → Ala (abc) + AKG (defgh) |
| v43 | 3PG (abc) + Glu (defgh) → Ser (abc) + AKG (defgh) + NADH |
| v44 | Ser (abc) ↔ Gly (ab) + MEETHF (c) |
| v45 | Gly (ab) ↔ CO2 (a) + MEETHF (b) + NADH + NH3 |
| v46 | Thr (abcd) → Gly (ab) + AcCoA (cd) + NADH |
| v47 | Ser (abc) + AcCoA (de) + 3 ATP + 4 NADPH + SO4 → Cys (abc) + Ac (de) |
| v48 | Asp (abcd) + Pyr (efg) + Glu (hijkl) + SucCoA (mnop) + ATP + 2 NADPH →  LL-DAP (½ abcdgfe + ½ efgdcba) + AKG (hijkl) + Suc (½ mnop + ½ ponm) |
| v49 | LL-DAP (½ abcdefg + ½ gfedcba) → Lys (abcdef) + CO2 (g) |
| v50 | Asp (abcd) + 2 ATP + 2 NADPH → Thr (abcd) |
| v51 | Asp (abcd) + METHF (e) + Cys (fgh) + SucCoA (ijkl) + ATP + 2 NADPH →  Met (abcde) + Pyr (fgh) + Suc (½ ijkl + ½ lkji) + NH3 |
| v52 | Pyr (abc) + Pyr (def) + Glu (ghijk) + NADPH → Val (abcef) + CO2 (d) + AKG (ghijk) |
| v53 | AcCoA (ab) + Pyr (cde) + Pyr (fgh) + Glu (ijklm) + NADPH →  Leu (abdghe) + CO2 (c) + CO2 (f) + AKG (ijklm) + NADH |
| v54 | Thr (abcd) + Pyr (efg) + Glu (hijkl) + NADPH → Ile (abfcdg) + CO2 (e) + AKG (hijkl) + NH3 |
| v55 | PEP (abc) + PEP (def) + E4P (ghij) + Glu (klmno) + ATP + NADPH →  Phe (abcefghij) + CO2 (d) + AKG (klmno) |
| v56 | PEP (abc) + PEP (def) + E4P (ghij) + Glu (klmno) + ATP + NADPH →  Tyr (abcefghij) + CO2 (d) + AKG (klmno) + NADH |
| v57 | Ser (abc) + R5P (defgh) + PEP (ijk) + E4P (lmno) + PEP (pqr) + Gln (stuvw) + 3 ATP + NADPH →  Trp (abcedklmnoj) + CO2 (i) + GAP (fgh) + Pyr (pqr) + Glu (stuvw) |
| v58 | R5P (abcde) + FTHF (f) + Gln (ghijk) + Asp (lmno) + 5 ATP →  His (edcbaf) + AKG (ghijk) + Fum (lmno) + 2 NADH |
|  | |
| **One-Carbon Metabolism** | |
| v59 | MEETHF (a) + NADH → METHF (a) |
| v60 | MEETHF (a) → FTHF (a) + NADPH |
|  | |
| **Oxidative Phosphorylation** | |
| v61 | NADH + ½ O2 → 2 ATP |
| v62 | FADH2 + ½ O2 → 1 ATP |
|  | |
| **Transhydrogenation** | |
| v63 | NADH ↔ NADPH |
|  | |
| **ATP Hydrolysis** | |
| v64 | ATP → ATP:ext |
|  | |
| **Transport** | |
| v65 | Ac (ab) → Ac.ext (ab) |
| v66 | CO2 (a) → CO2.ext (a) |
| v67 | O2.ext → O2 |
| v68 | NH3.ext → NH3 |
| v69 | SO4.ext → SO4 |
|  | |
| **Biomass Formation** | |
| v70 | 0.488 Ala + 0.281 Arg + 0.229 Asn + 0.229 Asp + 0.087 Cys + 0.250 Glu + 0.250 Gln + 0.582 Gly + 0.090 His + 0.276 Ile + 0.428 Leu + 0.326 Lys + 0.146 Met + 0.176 Phe + 0.210 Pro + 0.205 Ser + 0.241 Thr + 0.054 Trp + 0.131 Tyr + 0.402 Val + 0.205 G6P + 0.071 F6P + 0.754 R5P + 0.129 GAP + 0.619 3PG + 0.051 PEP + 0.083 Pyr + 2.510 AcCoA + 0.087 AKG + 0.340 OAC + 0.443 MEETHF + 33.247 ATP + 5.363 NADPH → 39.68 Biomass + 1.455 NADH |
|  | |
| **CO2 Exchange** | |
| v71 | CO2.unlabeled (a) + CO2 (b) → CO2 (a) + CO2.out (b) |

The net effect of reaction v71 is exchange of intracellular CO2 for an unlabeled CO2 without affecting intracellular carbon balances.