

Table 6: *H. sapiens* Recon 1 demand and exchange reactions. Demand reactions are intrasystem sources or sinks which allow unlimited production or consumption of a specified metabolite. Exchange reactions describe metabolite entry or exit across the system boundary (the interface between the extracellular compartment and cellular environment). Compartmentalization is denoted by the following abbreviations. All reactions occur entirely within one compartment.

Compartment Abbreviations

| | |
|----------------------|----------------------------|
| [c], cytoplasm | [m], mitochondrion |
| [e], extracellular | [n], nucleus |
| [g], Golgi apparatus | [r], endoplasmic reticulum |
| [l], lysosome | [x], peroxisome |

| Abbreviation | Reaction Name | Reaction |
|--------------------------|---|-----------------------------|
| DM_13-cis-oretn(n) | 13-cis-oxo-retinoic acid demand | [n] : 13-cis-oretn --> |
| DM_13-cis-retn(n) | 13-cis-retinoate demand | [n] : 13-cis-retn --> |
| DM_Asn-X-Ser/Thr(ly) | DM_Asn-X-Ser/Thr(ly) | [l] : Asn-X-Ser/Thr --> |
| DM_avite1(c) | alpha-Tocopherol demand | [c] : avite1 --> |
| DM_avite2(c) | alpha-Tocotrienol demand | [c] : avite2 --> |
| DM_bvite(c) | beta-tocopherol demand | [c] : bvite --> |
| DM_datp(m) | dATP demand | [m] : datp --> |
| DM_datp(n) | DM_datp(n) | [n] : datp --> |
| DM_dctp(m) | dCTP demand | [m] : dctp --> |
| DM_dctp(n) | DM_dctp(n) | [n] : dctp --> |
| DM_dgtp(m) | DM_dgtp(m) | [m] : dgtp --> |
| DM_dgtp(n) | DM_dgtp(n) | [n] : dgtp --> |
| DM_dsT_antigen(g) | DM_dsT_antigen(g) | [g] : dsT_antigen --> |
| DM_dttp(m) | dTTP demand | [m] : dttp --> |
| DM_dttp(n) | DM_dttp(n) | [n] : dttp --> |
| DM_ethamp(r) | Ethanolamine phosphate demand | [r] : ethamp --> |
| DM_gpi_sig(er) | DM_gpi_sig(er) | [r] : gpi_sig --> |
| DM_hretn(n) | 4 hydroxy retinoic acid demand | [n] : hretn --> |
| DM_kdn(c) | DM_kdn(c) | [c] : kdn --> |
| DM_melanin(c) | DM_melanin(c) | [c] : melanin --> |
| DM_oretn(n) | 4-oxo-retenoic acid demand | [n] : oretn --> |
| DM_Ser/Thr(ly) | DM_Ser/Thr(ly) | [l] : Ser/Thr --> |
| DM_Ser-Gly/Ala-X-Gly(ly) | DM_Ser-Gly/Ala-X-Gly(ly) | [l] : Ser-Gly/Ala-X-Gly --> |
| DM_sprm(c) | DM_sprm(c) | [c] : sprm --> |
| DM_sTn_antigen(g) | DM_sTn_antigen(g) | [g] : sTn_antigen --> |
| DM_yvite(c) | gamma-Tocopherol demand | [c] : yvite --> |
| EX_10fhf(e) | 10-Formyltetrahydrofolate exchange | [e] : 10fhf <=> |
| EX_10fhf5glu(e) | 10-formyltetrahydrofolate-[Glu](5) exchange | [e] : 10fhf5glu <=> |
| EX_10fhf6glu(e) | 10-formyltetrahydrofolate-[Glu](6) exchange | [e] : 10fhf6glu <=> |
| EX_10fhf7glu(e) | 10-formyltetrahydrofolate-[Glu](7) exchange | [e] : 10fhf7glu <=> |
| EX_11-cis-retfa(e) | fatty acid 11-cis-retinol exchange | [e] : 11-cis-retfa <=> |
| EX_13-cis-retnglc(e) | 13-cis-retinoyl glucuronide exchange | [e] : 13-cis-retnglc <=> |
| EX_1glyc_hs(e) | 1 acyl phosphoglycerol exchange | [e] : 1glyc_hs <=> |
| EX_1mncam(e) | 1-Methylnicotinamide exchange | [e] : 1mncam <=> |
| EX_2425dhvuid2(e) | 24R,25-Dihydroxyvitamin D2 exchange | [e] : 2425dhvuid2 <=> |
| EX_2425dhvuid3(e) | 24R,25-Dihydroxyvitamin D3 exchange | [e] : 2425dhvuid3 <=> |
| EX_24nph(e) | 2,4 dihydroxy nitrophenol exchange | [e] : 24nph <=> |
| EX_25hvid2(e) | 25-Hydroxyvitamin D2 exchange | [e] : 25hvid2 <=> |
| EX_25hvid3(e) | 25-Hydroxyvitamin D3 exchange | [e] : 25hvid3 <=> |
| EX_2hb(e) | 2-Hydroxybutyrate exchange | [e] : 2hb <=> |
| EX_2mciit(e) | 2-Methylcitrate exchange | [e] : 2mciit <=> |
| EX_34dhoxpeg(e) | 3,4-Dihydroxyphenylethyleneglycol exchange | [e] : 34dhoxpeg <=> |
| EX_34dhphe(e) | 3,4-Dihydroxy-L-phenylalanine exchange | [e] : 34dhphe <=> |
| EX_35cgmp(e) | 3',5'-Cyclic GMP exchange | [e] : 35cgmp <=> |
| EX_3aib(e) | L-3-Amino-isobutanoate exchange | [e] : 3aib <=> |
| EX_3aib-D(e) | D-3-Amino-isobutanoate exchange | [e] : 3aib-D <=> |
| EX_3mlda(e) | 3-Methylimidazoleacetic acid exchange | [e] : 3mlda <=> |
| EX_4abut(e) | 4-Aminobutanoate exchange | [e] : 4abut <=> |
| EX_4hdebrisoquine(e) | 4 hydroxy debrisoquine exchange | [e] : 4hdebrisoquine <=> |
| EX_4hphac(e) | 4-Hydroxyphenylacetate exchange | [e] : 4hphac <=> |
| EX_4mtolbutamide(e) | 4 hydroxy tolbutamide exchange | [e] : 4mtolbutamide <=> |
| EX_4nph(e) | 4-Nitrophenol exchange | [e] : 4nph <=> |
| EX_4nphsf(e) | 4-Nitrophenyl sulfate exchange | [e] : 4nphsf <=> |
| EX_4pyrdx(e) | 4-Pyridoxate exchange | [e] : 4pyrdx <=> |
| EX_5adtststerone(e) | 5alpha-Dihydrotestosterone exchange | [e] : 5adtststerone <=> |
| EX_5adtststeroneglc(e) | 5alpha-Dihydrotestosterone glucuronide exchange | [e] : 5adtststeroneglc <=> |
| EX_5adtststerones(e) | 5alpha-Dihydrotestosterone sulfate exchange | [e] : 5adtststerones <=> |
| EX_5dhf(e) | pentaglutamyl folate (DHF) exchange | [e] : 5dhf <=> |

| Abbreviation | Reaction Name | Reaction |
|--|---|--|
| EX_5fthf(e) | 5-Formyltetrahydrofolate exchange | [e] : 5fthf <=> |
| EX_5homeprazole(e) | 5 hydroxy omeprazole exchange | [e] : 5homeprazole <=> |
| EX_5htrp(e) | 5-Hydroxy-L-tryptophan exchange | [e] : 5htrp <=> |
| EX_5mthf(e) | 5-Methyltetrahydrofolate exchange | [e] : 5mthf <=> |
| EX_5thf(e) | pentaglutamyl folate (THF) exchange | [e] : 5thf <=> |
| EX_6dhf(e) | hexaglutamyl folate (DHF) exchange | [e] : 6dhf <=> |
| EX_6htststerone(e) | 6 beta hydroxy testosterone exchange | [e] : 6htststerone <=> |
| EX_6thf(e) | hexaglutamyl folate (THF) exchange | [e] : 6thf <=> |
| EX_7dhf(e) | heptaglutamyl folate (DHF) exchange | [e] : 7dhf <=> |
| EX_7thf(e) | heptaglutamyl folate (THF) exchange | [e] : 7thf <=> |
| EX_9-cis-retfa(e) | fatty acid 9-cis-retinol exchange | [e] : 9-cis-retfa <=> |
| EX_abt(e) | L-Arabinitol exchange | [e] : abt <=> |
| EX_ac(e) | Acetate exchange | [e] : ac <=> |
| EX_acac(e) | Acetoacetate exchange | [e] : acac <=> |
| EX_acald(e) | Acetaldehyde exchange | [e] : acald <=> |
| EX_acetone(e) | Acetone exchange | [e] : acetone <=> |
| EX_acgalfucgalacgalfuc12gal14acglcgalgluside_hs(e) | Type IIIA glycolipid exchange | [e] : acgalfucgalacgalfuc12gal14acglcgalgluside_hs <=> |
| EX_acgalfucgalacgalfucgalacglcgal14acglcgalgluside_hs(e) | Type IIIAb exchange | [e] : acgalfucgalacgalfucgalacglcgal14acglcgalgluside_hs <=> |
| EX_acgam(e) | N-Acetyl-D-glucosamine exchange | [e] : acgam <=> |
| EX_ach(e) | Acetylcholine exchange | [e] : ach <=> |
| EX_acn13acngalgsbide_hs(e) | sialyl (1,3) sialyl (2,6) galactosylgloboside (homo sapiens) exchange | [e] : acn13acngalgsbide_hs <=> |
| EX_acn23acngalgsbide_hs(e) | sialyl (2,3) sialyl (2,6) galactosylgloboside (homo sapiens) exchange | [e] : acn23acngalgsbide_hs <=> |
| EX_acnacngal14acglcgalgluside_hs(e) | 3',8'-LD1 exchange | [e] : acnacngal14acglcgalgluside_hs <=> |
| EX_acnacngalgsbide_hs(e) | disialyl galactosylgloboside (homo sapiens) exchange | [e] : acnacngalgsbide_hs <=> |
| EX_acngalacglcgal14acglcgalgluside_hs(e) | VI3NeuAc-nLc6Cer exchange | [e] : acngalacglcgal14acglcgalgluside_hs <=> |
| EX_ade(e) | Adenine exchange | [e] : ade <=> |
| EX_adn(e) | Adenosine exchange | [e] : adn <=> |
| EX_adp | adp exchange | [e] : adp <=> |
| EX_adprpb(e) | ADPribose 2'-phosphate exchange | [e] : adprpb <=> |
| EX_adprib(e) | ADPribose exchange | [e] : adprib <=> |
| EX_adrn(e) | adrenic acid exchange | [e] : adrn <=> |
| EX_adrnl(e) | Adrenaline exchange | [e] : adrnl <=> |
| EX_aflatoxin(e) | aflatoxin B1 exchange | [e] : aflatoxin <=> |
| EX_ahandrostanglc(e) | Etiocholan-3alpha-ol-17-one 3-glucuronide exchange | [e] : ahandrostanglc <=> |
| EX_ak2lgchol_hs(e) | 1-alkyl 2-lysoglycerol 3-phosphocholine exchange | [e] : ak2lgchol_hs <=> |
| EX_akg(e) | 2-Oxoglutarate exchange | [e] : akg <=> |
| EX_ala-B(e) | beta-Alanine exchange | [e] : ala-B <=> |
| EX_ala-D(e) | D-Alanine exchange | [e] : ala-D <=> |
| EX_ala-L(e) | L-Alanine exchange | [e] : ala-L <=> |
| EX_aldstn(e) | Aldosterone exchange | [e] : aldstn <=> |
| EX_amp(e) | AMP exchange | [e] : amp <=> |
| EX_andrstrn(e) | Androsterone exchange | [e] : andrstrn <=> |
| EX_andrstrnglc(e) | androsterone glucuronide exchange | [e] : andrstrnglc <=> |
| EX_antipyrene(e) | antipyrene exchange | [e] : antipyrene <=> |
| EX_apnnox(e) | alpha-Pinene-oxide exchange | [e] : apnnox <=> |
| EX_appnn(e) | (+)-alpha-Pinene exchange | [e] : appnn <=> |
| EX_aprgstrn(e) | 20alpha-Hydroxyprogesterone exchange | [e] : aprgstrn <=> |
| EX_aqcobal(e) | Aquacob(III)alamin exchange | [e] : aqcobal <=> |
| EX_arab-L(e) | L-Arabinose exchange | [e] : arab-L <=> |
| EX_arach(e) | Arachidic acid exchange | [e] : arach <=> |
| EX_arachd(e) | nC20:4 exchange | [e] : arachd <=> |
| EX_arg-L(e) | L-Arginine exchange | [e] : arg-L <=> |
| EX_ascb-L(e) | L-Ascorbate exchange | [e] : ascb-L <=> |
| EX_asn-L(e) | L-Asparagine exchange | [e] : asn-L <=> |
| EX_asp-D(e) | D-Aspartate exchange | [e] : asp-D <=> |

| Abbreviation | Reaction Name | Reaction |
|-----------------------|--|---------------------------|
| EX_asp-L(e) | L-Aspartate exchange | [e] : asp-L <=> |
| EX_atp(e) | ATP exchange | [e] : atp <=> |
| EX_avite1(e) | alpha-Tocopherol exchange | [e] : avite1 <=> |
| EX_avite2(e) | alpha-Tocotrienol exchange | [e] : avite2 <=> |
| EX_bhb(e) | (R)-3-Hydroxybutanoate transport via H+ symport | [e] : bhb <=> |
| EX_bildglcur(e) | Bilirubin beta-diglucuronide exchange | [e] : bildglcur <=> |
| EX_bilglcur(e) | Bilirubin monoglucuronide exchange | [e] : bilglcur <=> |
| EX_bilirub(e) | Bilirubin exchange | [e] : bilirub <=> |
| EX_biocyt(e) | Biocytin exchange | [e] : biocyt <=> |
| EX_btn(e) | Biotin exchange | [e] : btn <=> |
| EX_but(e) | Butyrate (n-C4:0) exchange | [e] : but <=> |
| EX_bvite(e) | beta-tocopherol exchange | [e] : bvite <=> |
| EX_bz(e) | Benzoate exchange | [e] : bz <=> |
| EX_ca2(e) | Calcium exchange | [e] : ca2 <=> |
| EX_camp(e) | cAMP exchange | [e] : camp <=> |
| EX_caro(e) | beta-Carotene exchange | [e] : caro <=> |
| EX_carveol(e) | (E)-carveol exchange | [e] : carveol <=> |
| EX_cca_d3(e) | Calcitric acid (D3) exchange | [e] : cca_d3 <=> |
| EX_cgly(e) | Cys-Gly exchange | [e] : cgly <=> |
| EX_chol(e) | Choline exchange | [e] : chol <=> |
| EX_cholate(e) | Cholate exchange | [e] : cholate <=> |
| EX_chsterol(e) | Cholesterol exchange | [e] : chsterol <=> |
| EX_chtn(e) | chitin exchange | [e] : chtn <=> |
| EX_cit(e) | Citrate exchange | [e] : cit <=> |
| EX_cl(e) | Chloride exchange | [e] : cl <=> |
| EX_CLPND(e) | clupanodonic acid (docosapentaenoic (n-3)) exchange | [e] : clpnd <=> |
| EX_cmp(e) | CMP exchange | [e] : cmp <=> |
| EX_co(e) | Carbon monoxide exchange | [e] : co <=> |
| EX_co2(e) | CO2 exchange | [e] : co2 <=> |
| EX_coumarin(e) | coumarin exchange | [e] : coumarin <=> |
| EX_creat(e) | Creatine exchange | [e] : creat <=> |
| EX_crmp_hs(e) | Ceramide 1-phosphate exchange | [e] : crmp_hs <=> |
| EX_crn(e) | L-Carnitine exchange | [e] : crn <=> |
| EX_crvnc(e) | nC22:6 exchange | [e] : crvnc <=> |
| EX_csn(e) | Cytosine exchange | [e] : csn <=> |
| EX_cspg_a(e) | chondroitin sulfate A (GalNAc4S-GlcA) proteoglycan exchange | [e] : cspg_a <=> |
| EX_cspg_b(e) | chondroitin sulfate B / dermatan sulfate (IdoA2S-GalNAc4S) proteoglycan exchange | [e] : cspg_b <=> |
| EX_cspg_c(e) | chondroitin sulfate C (GalNAc6S-GlcA) proteoglycan exchange | [e] : cspg_c <=> |
| EX_cspg_d(e) | chondroitin sulfate D (GlcNAc6S-GlcA2S) proteoglycan exchange | [e] : cspg_d <=> |
| EX_cspg_e(e) | chondroitin sulfate E (GalNAc4,6diS-GlcA) proteoglycan exchange | [e] : cspg_e <=> |
| EX_cyan(e) | Hydrogen cyanide exchange | [e] : cyan <=> |
| EX_cys-L(e) | L-Cysteine exchange | [e] : cys-L <=> |
| EX_cyt(d) | Cytidine exchange | [e] : cytd <=> |
| EX_dad-2(e) | Deoxyadenosine exchange | [e] : dad-2 <=> |
| EX_dad-5(e) | 5'-Deoxyadenosine exchange | [e] : dad-5 <=> |
| EX_dag_hs(e) | diacylglycerol (homo sapiens) exchange | [e] : dag_hs <=> |
| EX_dcsptn1(e) | docosa-4,7,10,13,16-pentaenoic acid (n-6) exchange | [e] : dcsptn1 <=> |
| EX_dcyt(e) | Deoxycytidine exchange | [e] : dcyt <=> |
| EX_debrisoquine(e) | debrisoquine exchange | [e] : debrisoquine <=> |
| EX_dgchol(e) | Chenodeoxyglycocholate exchange | [e] : dgchol <=> |
| EX_dgsn(e) | Deoxyguanosine exchange | [e] : dgsn <=> |
| EX_dhdascb(e) | Dehydroascorbate exchange | [e] : dhdascb <=> |
| EX_dheas(e) | Dehydroepiandrosterone sulfate exchange | [e] : dheas <=> |
| EX_dhf(e) | 7,8-Dihydrofolate exchange | [e] : dhf <=> |
| EX_digalsalside_hs(e) | Digalactosylceramidesulfate exchange | [e] : digalsalside_hs <=> |
| EX_din(e) | Deoxyinosine exchange | [e] : din <=> |
| EX_dlnl(e) | dihomo-gamma-linolenic acid (n-6) exchange | [e] : dlnl <=> |

| Abbreviation | Reaction Name | Reaction |
|---|---|---|
| EX_dmantpyrine(e) | demethylated antipyrine exchange | [e] : dmantpyrine <=> |
| EX_dmhptcrn(e) | 2,6 dimethylheptanoyl carnitine exchange | [e] : dmhptcrn <=> |
| EX_dopa(e) | Dopamine exchange | [e] : dopa <=> |
| EX_dopasf(e) | Dopamine 3-O-sulfate exchange | [e] : dopasf <=> |
| EX_drib(e) | Deoxyribose exchange | [e] : drib <=> |
| EX_duri(e) | Deoxyuridine exchange | [e] : duri <=> |
| EX_eafatoxin(e) | 8,9 epoxy aflatoxin B1 exchange | [e] : eafatoxin <=> |
| EX_ebastine(e) | ebastine exchange | [e] : ebastine <=> |
| EX_ebastineoh(e) | hydroxylated ebastine exchange | [e] : ebastineoh <=> |
| EX_eicostet(e) | eicosatetraoic acid exchange | [e] : eicostet <=> |
| EX_elaid(e) | elaidic acid exchange | [e] : elaid <=> |
| EX_estradiolglc(e) | estradiol glucuronide exchange | [e] : estradiolglc <=> |
| EX_estriolglc(e) | 16-Glucuronide-estriol exchange | [e] : estriolglc <=> |
| EX_estroneglc(e) | estrone glucuronide exchange | [e] : estroneglc <=> |
| EX_estrone(s) | Estrone 3-sulfate exchange | [e] : estrones <=> |
| EX_etoh(e) | Ethanol exchange | [e] : etoh <=> |
| EX_fe2(e) | Fe2+ exchange | [e] : fe2 <=> |
| EX_fe3(e) | Fe3+ exchange | [e] : fe3 <=> |
| EX_fol(e) | Folate exchange | [e] : fol <=> |
| EX_for(e) | Formate exchange | [e] : for <=> |
| EX_fru(e) | D-Fructose exchange | [e] : fru <=> |
| EX_fuc13galacglcgal14acglcgalgluside_hs(e) | III3Fuc-nLc6Cer exchange | [e] : fuc13galacglcgal14acglcgalgluside_hs <=> |
| EX_fuc14galacglcgalgluside_hs(e) | Lea glycolipid exchange | [e] : fuc14galacglcgalgluside_hs <=> |
| EX_fucacgalfucgalacglcgalgluside_hs(e) | (Gal)2 (GalNAc)1 (Glc)1 (GlcNAc)1 (LFuc)2 (Cer)1 exchange | [e] : fucacgalfucgalacglcgalgluside_hs <=> |
| EX_fucacngal14acglcgalgluside_hs(e) | IV3-a-NeuAc,III3-a-Fuc-nLc4Cer exchange | [e] : fucacngal14acglcgalgluside_hs <=> |
| EX_fucacngalacglcgalgluside_hs(e) | IV3-a-Neu5Ac,III4-a-Fuc-Lc4Cer exchange | [e] : fucacngalacglcgalgluside_hs <=> |
| EX_fucfuc12gal14acglcgalgluside_hs(e) | Ley glycolipid exchange | [e] : fucfuc12gal14acglcgalgluside_hs <=> |
| EX_fucfuc132galacglcgal14acglcgalgluside_hs(e) | V3Fuc,III3Fuc-nLc6Cer exchange | [e] : fucfuc132galacglcgal14acglcgalgluside_hs <=> |
| EX_fucfucfucgalacglc13galacglcgal14acglcgalgluside_hs(e) | (Gal)4 (Glc)1 (GlcNAc)3 (LFuc)3 (Cer)1 exchange | [e] : fucfucfucgalacglc13galacglcgal14acglcgalgluside_hs <=> |
| EX_fucfucfucgalacglcgal14acglcgalgluside_hs(e) | (Gal)3 (Glc)1 (GlcNAc)2 (LFuc)3 (Cer)1 exchange | [e] : fucfucfucgalacglcgal14acglcgalgluside_hs <=> |
| EX_fucfucgalacglcgalgluside_hs(e) | Leb glycolipid exchange | [e] : fucfucgalacglcgalgluside_hs <=> |
| EX_fucgal14acglcgalgluside_hs(e) | Lacto-N-fucopentaosyl III ceramide exchange | [e] : fucgal14acglcgalgluside_hs <=> |
| EX_fucgalfucgalacglcgalgluside_hs(e) | (Gal)3 (Glc)1 (GlcNAc)1 (LFuc)2 (Cer)1 exchange | [e] : fucgalfucgalacglcgalgluside_hs <=> |
| EX_fucgalgsbside_hs(e) | fucosyl galactosylgloboside (homo sapiens) exchange | [e] : fucgalgsbside_hs <=> |
| EX_fuc-L(e) | L-Fucose exchange | [e] : fuc-L <=> |
| EX_gal(e) | D-Galactose exchange | [e] : gal <=> |
| EX_galacglcgalgsbside_hs(e) | Gal-GlcNAc-Gal globoside (homo sapiens) exchange | [e] : galacglcgalgsbside_hs <=> |
| EX_galfuc12gal14acglcgalgluside_hs(e) | (Gal)3 (Glc)1 (GlcNAc)1 (LFuc)1 (Cer)1 exchange | [e] : galfuc12gal14acglcgalgluside_hs <=> |
| EX_galfucgalacglcgal14acglcgalgluside_hs(e) | (Gal)4 (Glc)1 (GlcNAc)2 (LFuc)1 (Cer)1 exchange | [e] : galfucgalacglcgal14acglcgalgluside_hs <=> |
| EX_galgalfucfucgalacglcgalacglcgal14acglcgalgluside_hs(e) | (Gal)6 (Glc)1 (GlcNAc)3 (LFuc)2 (Cer)1 exchange | [e] : galgalfucfucgalacglcgalacglcgal14acglcgalgluside_hs <=> |
| EX_galgalgaltherm_hs(e) | Gal-Gal-Gal-Gal-Glc-Cer (homo sapiens) exchange | [e] : galgalgaltherm_hs <=> |
| EX_gam(e) | D-Glucosamine exchange | [e] : gam <=> |
| EX_gbside_hs(e) | globoside (homo sapiens) exchange | [e] : gbside_hs <=> |
| EX_gchola(e) | glycocholate exchange | [e] : gchola <=> |
| EX_gd1b2_hs(e) | GD1beta (homo sapiens) exchange | [e] : gd1b2_hs <=> |
| EX_gd1c_hs(e) | GD1c (homo sapiens) exchange | [e] : gd1c_hs <=> |
| EX_gdchola(e) | glycochenodeoxycholate exchange | [e] : gdchola <=> |
| EX_gdp(e) | GDP exchange | [e] : gdp <=> |

| Abbreviation | Reaction Name | Reaction |
|--------------------|--|------------------------|
| EX_glc(e) | D-Glucose exchange | [e] : glc-D <=> |
| EX_gln-L(e) | L-Glutamine exchange | [e] : gln-L <=> |
| EX_gluala(e) | 5-L-Glutamyl-L-alanine exchange | [e] : gluala <=> |
| EX_glu-L(e) | L-Glutamate exchange | [e] : glu-L <=> |
| EX_gly(e) | Glycine exchange | [e] : gly <=> |
| EX_glyb(e) | Glycine betaine exchange | [e] : glyb <=> |
| EX_glyc(e) | Glycerol exchange | [e] : glyc <=> |
| EX_glyc-S(e) | (S)-Glycerate exchange | [e] : glyc-S <=> |
| EX_glygn2(e) | glycogen, structure 2 (glycogenin-1,6-[7[1,4-Glc], 4[1,4-Glc]]) exchange | [e] : glygn2 <=> |
| EX_glygn4(e) | glycogen, structure 4 (glycogenin-1,6-[2[1,4-Glc], [1,4-Glc]]) exchange | [e] : glygn4 <=> |
| EX_glygn5(e) | glycogen, structure 5 (glycogenin-2[1,4-Glc]) exchange | [e] : glygn5 <=> |
| EX_gmp(e) | GMP exchange | [e] : gmp <=> |
| EX_gp1c_hs(e) | GP1c (homo sapiens) exchange | [e] : gp1c_hs <=> |
| EX_gp1calpha_hs(e) | GP1c alpha (homo sapiens) exchange | [e] : gp1calpha_hs <=> |
| EX_gq1b_hs(e) | GQ1b (homo sapiens) exchange | [e] : gq1b_hs <=> |
| EX_gq1balpha_hs(e) | GQ1balpha (homo sapiens) exchange | [e] : gq1balpha_hs <=> |
| EX_gsn(e) | Guanosine exchange | [e] : gsn <=> |
| EX_gt1a_hs(e) | GT1a (homo sapiens) exchange | [e] : gt1a_hs <=> |
| EX_gthox(e) | Oxidized glutathione exchange | [e] : gthox <=> |
| EX_gthrd(e) | Reduced glutathione exchange | [e] : gthrd <=> |
| EX_gtp(e) | GTP exchange | [e] : gtp <=> |
| EX_gua(e) | Guanine exchange | [e] : gua <=> |
| EX_h(e) | H+ exchange | [e] : h <=> |
| EX_h2o(e) | H2O exchange | [e] : h2o <=> |
| EX_h2o2(e) | Hydrogen peroxide exchange | [e] : h2o2 <=> |
| EX_ha(e) | hyaluronan exchange | [e] : ha <=> |
| EX_ha_pre1(e) | hyaluronan biosynthesis, precursor 1 exchange | [e] : ha_pre1 <=> |
| EX_hco3(e) | Bicarbonate exchange | [e] : hco3 <=> |
| EX_hcoumarin(e) | hydroxy coumarin exchange | [e] : hcoumarin <=> |
| EX_hdca(e) | Hexadecanoate (n-C16:0) exchange | [e] : hdca <=> |
| EX_hdcea(e) | hexadecenoate (n-C16:1) exchange | [e] : hdcea <=> |
| EX_hestriatriol(e) | 4,17 dihydroxy estradiol exchange | [e] : hestriatriol <=> |
| EX_hexc(e) | hexacosanoate (n-C26:0) exchange | [e] : hexc <=> |
| EX_his-L(e) | L-Histidine exchange | [e] : his-L <=> |
| EX_hista(e) | Histamine exchange | [e] : hista <=> |
| EX_hom-L(e) | L-Homoserine exchange | [e] : hom-L <=> |
| EX_hpdc(a)(e) | heptadecanoate exchange | [e] : hpdc(a) <=> |
| EX_hspg(e) | heparan sulfate proteoglycan exchange | [e] : hspg <=> |
| EX_htaxol(e) | hydroxylated taxol exchange | [e] : htaxol <=> |
| EX_hxan(e) | Hypoxanthine exchange | [e] : hxan <=> |
| EX_i(e) | Iodide exchange | [e] : i <=> |
| EX_idp(e) | IDP exchange | [e] : idp <=> |
| EX_ile-L(e) | L-Isoleucine exchange | [e] : ile-L <=> |
| EX_imp(e) | IMP exchange | [e] : imp <=> |
| EX_inost(e) | myo-Inositol exchange | [e] : inost <=> |
| EX_ins(e) | Inosine exchange | [e] : ins <=> |
| EX_k(e) | K+ exchange | [e] : k <=> |
| EX_ksi(e) | keratan sulfate I exchange | [e] : ksi <=> |
| EX_ksi_deg1(e) | keratan sulfate I, degradation product 1 exchange | [e] : ksi_deg1 <=> |
| EX_ksii_core2(e) | keratan sulfate II (core 2-linked) exchange | [e] : ksii_core2 <=> |
| EX_ksii_core4(e) | keratan sulfate II (core 4-linked) exchange | [e] : ksii_core4 <=> |
| EX_lac-D(e) | D-lactate exchange | [e] : lac-D <=> |
| EX_lac-L(e) | L-Lactate exchange | [e] : lac-L <=> |
| EX_lcts(e) | Lactose exchange | [e] : lcts <=> |
| EX_Lcystin(e) | L-Cystine exchange | [e] : Lcystin <=> |
| EX_leuktrC4(e) | Leukotriene C4 exchange | [e] : leuktrC4 <=> |
| EX_leu-L(e) | L-Leucine exchange | [e] : leu-L <=> |
| EX_lgnc(e) | lignoceric acid exchange | [e] : lgnc <=> |
| EX_limnen(e) | Limonene exchange | [e] : limnen <=> |
| EX_lipoate(e) | Lipoate exchange | [e] : lipoate <=> |

| Abbreviation | Reaction Name | Reaction |
|--|--|-----------------------|
| EX_ineldc(e) | linoleic acid exchange | [e] : ineldc <=> |
| EX_inlc(e) | linoleic acid (all cis C18:2) exchange | [e] : inlc <=> |
| EX_inlc(e) [deleted 08/16/2005 05:23:37 PM] | linoleic acid exchange | [e] : inlc <=> |
| EX_inlnca(e) | alpha-Linolenic acid exchange | [e] : inlnca <=> |
| EX_inlncg(e) | gamma-linolenic acid exchange | [e] : inlncg <=> |
| EX_lpchol_hs(e) | lysophosphatidylcholine (homo sapiens) exchange | [e] : lpchol_hs <=> |
| EX_lys-L(e) | L-Lysine exchange | [e] : lys-L <=> |
| EX_mag_hs(e) | monoacylglycerol 2 (homo sapiens) exchange | [e] : mag_hs <=> |
| EX_malt(e) | Maltose exchange | [e] : malt <=> |
| EX_maltr(e) | Maltotriose exchange | [e] : maltr <=> |
| EX_man(e) | D-Mannose exchange | [e] : man <=> |
| EX_meoh(e) | methanol exchange | [e] : meoh <=> |
| EX_mepi(e) | Metanephrine exchange | [e] : mepi <=> |
| EX_mercplaccys(e) | 3-mercaptolactate-cysteine disulfide exchange | [e] : mercplaccys <=> |
| EX_met-L(e) | L-Methionine exchange | [e] : met-L <=> |
| EX_mthgxl(e) | Methylglyoxal exchange | [e] : mthgxl <=> |
| EX_n2m2nmasn(e) | N-Acetyl-beta-D-glucosaminyl-1,2-alpha-D-mannosyl-1,3-(N-acetyl-beta-D-glucosaminyl-1,2-alpha-D-mannosyl-1,6)-(N-acetyl-beta-D-glucosaminyl-1,4)-beta-D-mannosyl-1,4-N-acetyl-beta-D-glucosaminyl-R exchange | [e] : n2m2nmasn <=> |
| EX_na1(e) | Sodium exchange | [e] : na1 <=> |
| EX_nac(e) | Nicotinate exchange | [e] : nac <=> |
| EX_nad(e) | Nicotinamide adenine dinucleotide exchange | [e] : nad <=> |
| EX_nadp(e) | Nicotinamide adenine dinucleotide phosphate exchange | [e] : nadp <=> |
| EX_ncam(e) | Nicotinamide exchange | [e] : ncam <=> |
| EX_nh4(e) | Ammonia exchange | [e] : nh4 <=> |
| EX_nifedipine(e) | nifedipine exchange | [e] : nifedipine <=> |
| EX_no(e) | Nitric oxide exchange | [e] : no <=> |
| EX_npthl(e) | Naphthalene exchange | [e] : npthl <=> |
| EX_nrpphr(e) | Norepinephrine exchange | [e] : nrpphr <=> |
| EX_nrpphrsf(e) | Sulfate derivative of norepinephrine exchange | [e] : nrpphrsf <=> |
| EX_nrvnc(e) | nervonic acid exchange | [e] : nrvnc <=> |
| EX_o2(e) | O2 exchange | [e] : o2 <=> |
| EX_o2s(e) | Superoxide anion exchange | [e] : o2s <=> |
| EX_oagd3_hs(e) | 9-O-Acetylated GD3 (homo sapiens) exchange | [e] : oagd3_hs <=> |
| EX_oagt3_hs(e) | 9-O-Acetylated GT3 (homo sapiens) exchange | [e] : oagt3_hs <=> |
| EX_ocdca(e) | octadecanoate (n-C18:0) exchange | [e] : ocdca <=> |
| EX_ocdcea(e) | octadecenoate (n-C18:1) exchange | [e] : ocdcea <=> |
| EX_octa(e) | octanoate (n-C8:0) exchange | [e] : octa <=> |
| EX_oh1 | OH1 Exchange | [e] : oh1 <=> |
| EX_omeprazole(e) | omeprazole exchange | [e] : omeprazole <=> |
| EX_onpthl(e) | naphthalene epoxide exchange | [e] : onpthl <=> |
| EX_orn(e) | Ornithine exchange | [e] : orn <=> |
| EX_oxa(e) | Oxalate exchange | [e] : oxa <=> |
| EX_paf_hs(e) | 1-alkyl 2-acteylglycerol 3-phosphocholine (homo sapiens) exchange | [e] : paf_hs <=> |
| EX_pchol_hs(e) | Phosphatidylcholine (homo sapiens) exchange | [e] : pchol_hs <=> |
| EX_pe_hs(e) | phosphatidylethanolamine (homo sapiens) exchange | [e] : pe_hs <=> |
| EX_peplys(e) | Peptidyl-L-lysine exchange | [e] : peplys <=> |
| EX_perillyl(e) | Perillyl alcohol exchange | [e] : perillyl <=> |
| EX_pglyc_hs(e) | phosphatidylglycerol (homo sapiens) exchange | [e] : pglyc_hs <=> |
| EX_pheacgln(e) | alpha-N-Phenylacetyl-L-glutamine exchange | [e] : pheacgln <=> |

| Abbreviation | Reaction Name | Reaction |
|--|---|--|
| EX_phe-L(e) | L-Phenylalanine exchange | [e] : phe-L <=> |
| EX_pHEME(e) | Protoheme exchange | [e] : pHEME <=> |
| EX_phyQ(e) | Phylloquinone exchange | [e] : phyQ <=> |
| EX_phyt(e) | phytanic acid exchange | [e] : phyt <=> |
| EX_pi(e) | Phosphate exchange | [e] : pi <=> |
| EX_pnto-R(e) | (R)-Pantothenate exchange | [e] : pnto-R <=> |
| EX_ppa(e) | Propionate exchange | [e] : ppa <=> |
| EX_pro-D(e) | D-Proline exchange | [e] : pro-D <=> |
| EX_pro-L(e) | L-Proline exchange | [e] : pro-L <=> |
| EX_prostgd2(e) | Prostaglandin D2 exchange | [e] : prostgd2 <=> |
| EX_prostge1(e) | Prostaglandin E1 exchange | [e] : prostge1 <=> |
| EX_prostge2(e) | Prostaglandin E2 exchange | [e] : prostge2 <=> |
| EX_prostgf2(e) | Prostaglandin F2alpha exchange | [e] : prostgf2 <=> |
| EX_ps_hs(e) | phosphatidylserine (homo sapiens) exchange | [e] : ps_hs <=> |
| EX_ptdca(e) | pentadecanoate exchange | [e] : ptdca <=> |
| EX_pydam(e) | Pyridoxamine exchange | [e] : pydam <=> |
| EX_pydx(e) | Pyridoxal exchange | [e] : pydx <=> |
| EX_pydxn(e) | Pyridoxine exchange | [e] : pydxn <=> |
| EX_pyr(e) | Pyruvate exchange | [e] : pyr <=> |
| EX_rbt(e) | Ribitol exchange | [e] : rbt <=> |
| EX_retfa(e) | fatty acid retinol exchange | [e] : retfa <=> |
| EX_retinol(e) | Retinol exchange | [e] : retinol <=> |
| EX_retinol-9-cis(e) | 9-cis-retinol exchange | [e] : retinol-9-cis <=> |
| EX_retinol-cis-11(e) | cis-11-retinol exchange | [e] : retinol-cis-11 <=> |
| EX_retn(e) | Retinoate exchange | [e] : retn <=> |
| EX_retnlcl(e) | retinoyl glucuronide exchange | [e] : retnlcl <=> |
| EX_retpalm [deleted 10/09/2005 06:18:49 PM](e) | Retinyl palminate exchange | [e] : retpalm [deleted 10/09/2005 06:18:49 PM] <=> |
| EX_retpalm(e) [deleted 10/09/2005 06:38:54 PM] | Retinyl palminate exchange | [e] : retpalm [deleted 10/09/2005 06:18:49 PM] <=> |
| EX_rib-D(e) | D-Ribose exchange | [e] : rib-D <=> |
| EX_ribflv(e) | Riboflavin exchange | [e] : ribflv <=> |
| EX_Rtotal(e) | R total exchange | [e] : Rtotal <=> |
| EX_Rtotal2(e) | R total 2 position exchange | [e] : Rtotal2 <=> |
| EX_Rtotal3(e) | R total 3 position exchange | [e] : Rtotal3 <=> |
| EX_s2l2n2m2masn(e) | PA6 exchange | [e] : s2l2n2m2masn <=> |
| EX_s2l2n2m2masn(e) | de-Fuc form of PA6 exchange | [e] : s2l2n2m2masn <=> |
| EX_sarcs(e) | Sarcosine exchange | [e] : sarcs <=> |
| EX_sel(e) | Selenate exchange | [e] : sel <=> |
| EX_ser-D(e) | D-Serine exchange | [e] : ser-D <=> |
| EX_ser-L(e) | L-Serine exchange | [e] : ser-L <=> |
| EX_sl-L(e) | L-sulfolactate exchange | [e] : sl-L <=> |
| EX_so4(e) | Sulfate exchange | [e] : so4 <=> |
| EX_spc_hs(e) | sphingosylphosphorylcholine (homo sapiens) exchange | [e] : spc_hs <=> |
| EX_sph1p(e) | Sphinganine 1-phosphate exchange | [e] : sph1p <=> |
| EX_sphs1p(e) | Sphingosine 1-phosphate exchange | [e] : sphs1p <=> |
| EX_srtm(e) | Serotonin exchange | [e] : srtm <=> |
| EX_strch1(e) | starch, structure 1 (1,6-[7[1,4-Glc], 4[1,4-Glc]]) exchange | [e] : strch1 <=> |
| EX_strch2(e) | starch, structure 2 (1,6-[2[1,4-Glc], [1,4-Glc]]) exchange | [e] : strch2 <=> |
| EX_strdnc(e) | stearidonic acid exchange | [e] : strdnc <=> |
| EX_succ(e) | Succinate exchange | [e] : succ <=> |
| EX_sucr(e) | Sucrose exchange | [e] : sucr <=> |
| EX_tag_hs(e) | triacylglycerol (homo sapiens) exchange | [e] : tag_hs <=> |
| EX_tagat-D(e) | D-Tagatose exchange | [e] : tagat-D <=> |
| EX_taur(e) | Taurine exchange | [e] : taur <=> |
| EX_taxol(e) | paclitaxel exchange | [e] : taxol <=> |
| EX_tchola(e) | Taurocholic acid exchange | [e] : tchola <=> |
| EX_tcynt(e) | Thiocyanate exchange | [e] : tcynt <=> |
| EX_tdchola(e) | taurochenodeoxycholate exchange | [e] : tdchola <=> |
| EX_tethex3(e) | tetracosahexaenoic acid, n-3 exchange | [e] : tethex3 <=> |

| Abbreviation | Reaction Name | Reaction |
|---------------------|--|-------------------------|
| EX_tetpent3(e) | tetracosapentaenoic acid, n-3 exchange | [e] : tetpent3 <=> |
| EX_tetpent6(e) | tetracosapentaenoic acid, n-6 exchange | [e] : tetpent6 <=> |
| EX_tettet6(e) | tetracosatetraenoic acid n-6 exchange | [e] : tettet6 <=> |
| EX_thf(e) | 5,6,7,8-Tetrahydrofolate exchange | [e] : thf <=> |
| EX_thm(e) | Thiamin exchange | [e] : thm <=> |
| EX_thmmp(e) | Thiamin monophosphate exchange | [e] : thmmp <=> |
| EX_thmtp(e) | Thiamin triphosphate exchange | [e] : thmtp <=> |
| EX_thr-L(e) | L-Threonine exchange | [e] : thr-L <=> |
| EX_thym(e) | Thymine exchange | [e] : thym <=> |
| EX_thymd(e) | Thymidine exchange | [e] : thymd <=> |
| EX_thyox-L(e) | L-Thyroxine exchange | [e] : thyox-L <=> |
| EX_tmndnc(e) | timnodonic acid exchange | [e] : tmndnc <=> |
| EX_tolbutamide(e) | tolbutamide exchange | [e] : tolbutamide <=> |
| EX_tre(e) | Trehalose exchange | [e] : tre <=> |
| EX_triodthy(e) | Triiodothyronine exchange | [e] : triodthy <=> |
| EX_triodthysulf(e) | Triiodothyronine sulfate exchange | [e] : triodthysulf <=> |
| EX_trp-L(e) | L-Tryptophan exchange | [e] : trp-L <=> |
| EX_tststeroneglc(e) | testosterone glucuronide exchange | [e] : tststeroneglc <=> |
| EX_tststerones(e) | testosterone sulfate exchange | [e] : tststerones <=> |
| EX_tsul(e) | Thiosulfate exchange | [e] : tsul <=> |
| EX_ttdca(e) | tetradecanoate (n-C14:0) exchange | [e] : ttdca <=> |
| EX_txa2(e) | Thromboxane A2 exchange | [e] : txa2 <=> |
| EX_tymsf(e) | Tyramine O-sulfate exchange | [e] : tymsf <=> |
| EX_Tyr-ggn(e) | Tyr-194 of apo-glycogenin protein (primer for glycogen synthesis) exchange | [e] : Tyr-ggn <=> |
| EX_tyr-L(e) | L-Tyrosine exchange | [e] : tyr-L <=> |
| EX_udp(e) | UDP exchange | [e] : udp <=> |
| EX_ump(e) | UMP exchange | [e] : ump <=> |
| EX_ura(e) | Uracil exchange | [e] : ura <=> |
| EX_urate(e) | Urate exchange | [e] : urate <=> |
| EX_urea(e) | Urea exchange | [e] : urea <=> |
| EX_uri(e) | Uridine exchange | [e] : uri <=> |
| EX_utp(e) | UTP exchange | [e] : utp <=> |
| EX_vacc(e) | vaccenic acid exchange | [e] : vacc <=> |
| EX_val-L(e) | L-Valine exchange | [e] : val-L <=> |
| EX_vitd2(e) | Vitamin D2 exchange | [e] : vitd2 <=> |
| EX_vitd3(e) | Vitamin D3 exchange | [e] : vitd3 <=> |
| EX_whddca(e) | omega hydroxy dodecanoate (n-C12:0) exchange | [e] : whddca <=> |
| EX_whhdca(e) | omega hydroxy hexadecanoate (n-C16:0) exchange | [e] : whhdca <=> |
| EX_whtststerone(e) | w hydroxy testosterone exchange | [e] : whtststerone <=> |
| EX_whttdda(e) | omega hydroxy tetradecanoate (n-C14:0) exchange | [e] : whttdda <=> |
| EX_xolest_hs(e) | cholesterol ester exchange | [e] : xolest_hs <=> |
| EX_xolest2_hs(e) | cholesterol ester (from FULLR2) exchange | [e] : xolest2_hs <=> |
| EX_xoltri24(e) | 7-alpha,24(S)-Dihydroxycholesterol exchange | [e] : xoltri24 <=> |
| EX_xoltri25(e) | 7-alpha,25-Dihydroxycholesterol exchange | [e] : xoltri25 <=> |
| EX_xoltri27(e) | 7-alpha,27-Dihydroxycholesterol exchange | [e] : xoltri27 <=> |
| EX_xyl-D(e) | D-Xylose exchange | [e] : xyl-D <=> |
| EX_xylt(e) | Xylitol exchange | [e] : xylt <=> |
| EX_yvite(e) | gamma-Tocopherol exchange | [e] : yvite <=> |