2-HG - 2-Hydroxyglutarate
3-PHP - 3-Phosphate Hydroxypyruvate
3-Pser - 3-Phosphoserine
4AB - 4-Aminobutyraldehyde
4ABT - 4-Aminobutyrate Transaminase
4Fe-4S - Tetrakis(λ³-iron(1+) ion) Tetrasulfane Tetrasulfanide
4-HB - 4-Hydroxybenzoic Acid
4-HBA - 4-Hydroxybenzaldehyde
4-HBS - 4-Hydroxybenzoate Synthase
4-HCA - 4-Hydroxycinnamic Acid
4-MeI - 4-Methylimidazole
4-MeIA - Methylimidazole Acetate
4-MeIAase - Methylimidazole Acetate Hydrolase
5-HIA - 5-Hydroxyindoleacetaldehyde
5-HIAA - 5-Hydroxyindoleacetic acid
5-MTHF - 5-Methyltetrahydrofolate
5,10-MTHF - 5,10-MethyleneTetrahydroFolate
6PGL - 6-Phosphoglucono-δ-Lactone
6PG - 6-Phosphogluconate
6PGD - 6-Phosphogluconate Dehydrogenase
AA - Amino Acids
AAA - Acetoacetic Acid
AAC - Acetoacetyl-CoA
AAD - Acetoacetate Decarboxylase
AADC - Aromatic L-Amino Acid Decarboxylase
AAO - L-Amino-Acid Oxidase
ABCD4 - ATP-Binding Cassette 4
ACC - Acetate
ACC - Acetyl-CoA Carboxylase
ACMS - 2-Amino-3-Carboxymuconic-6-Semialdehyde Acid
ACSM1/2B - Mitochondrial Medium-chain Acyl-CoA Synthetases
A-CoA - Acetyl-CoA
AChE - Acetylcholinesterase
ACO2 - cis-Aconitate Decarboxylase
ACS - Acetyl-CoA Synthetase
ACTH - Adrenocorticotropic Hormone
ADC - Arginine Decarboxylase
ADK - Adenylate Kinase (Myokinase)
ADH - Alcohol Dehydrogenase
ADHFE - Hydroxyacid-Oxoacid Transhydrogenase
ADO - 2-Aminoethanethioldioxygenase
AdoCbl(III) - Adenosylcobalamin
ADP - Adenosine Diphosphate
ADS - Adenylsuccinate
ADSL - Adenylsuccinate Lyase
ADSS - Adenylosuccinate Synthetase
AFMID - Kynurenine Formamidase
AGAT - Arginine:Glycine Amidinotransferase
AGXT - Alanine-Glyoxylate Aminotransferase
AHCY - S-Adenosylhomocysteine Hydrolase
AICAR - 5-Aminoimidazole-4-Carboxamide Ribonucleotide
AIR - 5-Aminoimidazole Ribonucleotide
AIRS - AIR Synthetase
α-KB - α-Ketobutyrate
α-KG - α-Ketoglutarate
α-KGDH - alpha-Ketoglutarate Dehydrogenase
Ala - Alanine
ALD - Aldolase
ALDH - Aldehyde Dehydrogenase
ALP - Alkaline Phosphatase
ALT - Alanine Aminotransferase
AMP - Adenosine Monophosphate
AMPD - AMP Deaminase
AMPK - AMP-activated Protein Kinase
ARG1 - Arginase
AGS - Agmatinase
AR - Aldose Reductase
AO - Aldehyde Oxidase
APS - Adenosine-5'-Phosphosulfate
APSK - APS Kinase
AQP9 - Aquaporin-9
ASA - Argininosuccinate
ASDC - Aspartate Decarboxylase
ASL - Arginino Succinase
Asp - Aspartate
ASPT - Aspartate Transcarbamoylase
ASS - Argininosuccinate Synthetase
AST - Aspartate Aminotransferase
ASMT - Acetylserotonin O-Methyltransferase
ATP - Adenosine Triphosphate
BH_2 - Dihydrobiopterin
BH_4 - Tetrahydrobiopterin
BHB - β-hydroxybutyric Acid
BHMT - Betaine-Homocysteine S-methyltransferase
BPG - Biphosphoglycerate
BPGM - BPG Mutase
BPGP - 2,3 BPG Phosphatase
Br - Bromine
Ca - Calcium
CAIR - 5-Aminoimidazole-4-Carboxylate Ribonucleotide
cAMP - Cyclic Adenosine Monophosphate
Car - Carnosine
Car-AcAI-IA - Carnosine-Acetaldehyde-Imidazolilinone Adduct
CAT - Catalase
CBS - Cystathionine B-Synthase
CSAD - Cysteine Sulfinic Acid Decarboxylase
CDO - Cysteamine Dioxygenase
CDP - Cytidine 5'-Diphosphate
CK - Creatine Kinase
CGL - Cystathionine gamma-Lyase
CHACT - Glutathione-Specific gamma-Glutamylcyclotransferase 1
ChaT - Choline Acetyltransferase
CHDH - Choline Dehydrogenase
Cl - Chloride
CMP - Cytidine Monophosphate
CMPK - UMP-CMP Kinase
CNMT - Carnosine N-Methyl Transferase
CNDP - Cytosolic Non-Specific Dipeptidase
CO - Carbon Monoxide
CO_2 - Carbon Dioxide
Co - Cobalt
CoA - Coenzyme A
CoAH - CoA Hydrolase
CN - Hydrogen Cyanide
CNCbl(III) - Cyanocobalamin
Cobl(II)alamin [any] - AdoCbl(III), MeCbl(III), OH-Cobl(III)alamin
COMT - Catechol O-methyltrans
CP - Carbamoyl Phosphate
CPS1 - Carbamoyl Phosphate Synthase1
CR - Carbonyl Reductase
Cr - Chromium
Cre - Creatine
CRH - Corticotrophin-Releasing Hormone
CRNS - Carnosine Synthase
CS - Citrate Synthase
CSE - Cystathionase
CTP - Cytidine 5'-Triphosphate
Cu - Copper
CYP - Cytochrome P450 monooxygenase
DAT - Dopamine Transporter
DAO - Diamine Oxidase
DBH - Dopamine Beta Hydroxylase
DHBA - 3,4-Dihydroxybenzeneacetic Acid
DHF - Dihydrofolate
DHFR - Dihydrofolate Reductase
DHAP - Dihydroxyacetone Phosphate
DHI - 5,6-Dihydroxyindole
DHICA - 5,6-Dihydroxyindole-2-Carboxylic Acid
DHMA - 3,4-Dihydroxymandelaldehyde
DHMC - 3,4-Dihydroxymandelic Acid
DMG - Dimethylglycine
DMGDH - DMG Dehydrogenase
DHO - Dihydroorotate
DHOase - Dihydroorotase
DHODH - Dihydroorotate Dehydrogenase
DOPAC - 3,4-Dihydroxyphenylacetic Acid
DOPAL - 3,4-Dihydroxyphenylacetaldehyde
DPCK - DephosphoCoA Kinase
DT - L-Dopachrome Tautomerase
dTMP - Thymidine Monophosphate
dUMP - Deoxyuridine Monophosphate
E4P - Erythrose-4-Phosphate
ENO - Enolase
ENPP - Ectonucleotide Pyrophosphatase/Phosphodiesterase
ETHE1 - Sulphur Dioxygenase
F1,6BP - Fructose 1,6-Bisphosphate
F2,6BP - Fructose 2,6-Bisphosphate
F6P - Fructose-6-Phosphate
FAA - 4-Fumarylacetoacetic Acid
FAAS - Fumarylacetoacetase
FAD - Adeflavin
FADS - FAD Synthetase
FAICAR - 5-Formaminoimidazole-4-Carboxamide Ribonucleotide
FBPase - Fructose 1,6-Bisphosphatase
FBPase2 - Fructose 2,6-Bisphosphatase
Fe - Ferritin
FGAM - Formylglycinamidine Ribonucleotide
FGAR - Formylglycinamide Ribonucleotide
FIGLU - Formimidoylglutamic Acid
FIGLU-THF - Formiminoglutamate-THF
FMN - Flavin Mononucleotide
FMO - Flavin Monooxygenase
FOLH - Folate Hydrolase
FR - Flavin Reductase (uncharacterised, possibly MMACHC)
FS - Fumarase
FT - Formiminotransferas
FTase - AICAR Transformylase
FTCD - Formiminotransferase Cyclodeaminase
G3P - Glycerol-3-Phosphate
G6Pase - Glucose 6-Phosphatase
G6PD - Glucose-6-Phosphate Dehydrogenase
GABA - Gamma-Aminobutyric Acid
GAD - Glutamate Decarboxylase
GAG - Glycosaminoglycan
GAMT - S-Adenosylmethionine:Guanidinoacetate Methyltransferase
GAP - Glyceraldehyde-3-Phosphate
GAPDH - Glyceraldehyde 3-Phosphate Dehydrogenase
GARS - GAR Synthetase
GARTase - GAR Transformylase
GAT - Guanidinoacetate
GBBH - gamma-Butyrobetaine Hydroxylase
GCA - gamma-Glutamylcysteine Synthase
GCH1 - GTP Cyclohydrolase I
GCL - Glutamate-Cysteine Ligase
GDP - Guanosine Diphosphate
GDH - Glutamate Dehydrogenase
GFAT - Glutamine:Fructose-6P Amidotransferase
GGCT - gamma-Glutamyl Cyclotransferases
GHB - γ-Hydroxybutyrate
GK - Glucokinase
Glc-1,6-BP - Glucose-1,6-Bisphosphate
GlcNAc - N-Acetylglucosamine
GlcNAc-1-P - GlcNAc 1-Phosphate
GlcNAc-6-P - GlcNAc 6-Phosphate
GLN - Glutaminase
Gln - Glutamine
GLS - Glutathione Synthase
GLSH - Glutamate Dehydrogenase
Gly - Glycine
GLYCK - Glycerol Kinase
GLYDH - Glycolaldehyde Dehydrogenase
GLYP - Glycogen Phosphorylase
GLYS - Glycogen Synthase
Glut - Glutamate
GNMT - Glycine N-Methyltransferase
GOR - Glyoxylate Reductase
GOX - Glycolate Oxidase
GPD - Glycerol-3-Phosphate Dehydrogenase
GPX - Glutathione Peroxidase
GR - Glutathione Reductase
GS - Glutamine Synthetase
GS-Ado - S-Adenosylglutathione
GS-Me - S-Methylglutathione
GSA - Glutamate-5-Semialdehyde
GSH - Glutathione, reduced
GSK3β - Glycogen Synthase Kinase-3 beta
GSSG - Glutathione disulfide (oxidised)
GSSH - Glutathione Persulfide
GTP - Guanosine Triphosphate
GTase - Glycosyltransferases
H - Hydrogen
H_2O - Water
H_2O_2 - Hydrogen Peroxide
H_2S - Hydrogen Sulfide
H2NTP - 7,8-Dihydroneopterin Triphosphate
HAAO - 3-Hydroxyanthranilic Acid Dioxygenase
HAL - Histidine Ammonia-Lyase
HAS - Hyaluronic Acid Synthase
HBDH - Hydroxybutyrate Dehydrogenase
HCO_3 - Bicarbonate
HK - Hexokinase
HIF - Hypoxia-Inducible Factor
HGA - Homogentisic Acid
HGD - Homogentisate 1,2-dioxygenase
HMPAL - 3-Methoxy-4-Hydroxyphenylacetaldehyde
HMT - Histidine Methyltransferase
HOGA - 4-Hydroxy-2-Ketoglutarate Aldolase
HPCL - HydroxyPyruvate Carboxy-Lyase
HPRT - Hypoxanthine-Guanine Phosphoribosyltransferase
HT - Histidine Transaminase
HTMLA - β-hydroxy-ε-N-trimethyllysine aldolase
HTDH - Hypotaurine Dehydrogenase
HVA - Homovanillic Acid
HYPDH - 4-Hydroxyproline Dehydrogenase

I - Iodine
IAA - Imidazole Acetaldehyde
IAcA - Imidazole Acetic Acid
IAL - Imidazoleacetate-Lyase
ICL - Isocitrate Lyase
IDH - Isocitrate Dehydrogenase
IDO - Indoleamine 2,3-Dioxygenase
IFN - Interferon
IMP - Inosine Monophosphate
IMPDH - IMP Cyclohydrolase
IP3 - Inositol Trisphosphate
IQ - Indole-5,6-Quinone
K - Potassium
KAT - Kynurenine Aminotransferase
KMO - Kynurenine 3-Monooxygenase
KYNU - Kynureninase
LDH - Lactate Dehydrogenase
LMBD1 - Lysosomal Cobalamin Transport Escort Protein
LPA - Lipoamide
LPH4 - Lactoyl-PH4
MAA - Maleylacetoacetic Acid
MAAI - Maleylacetoacetate Isomerase
MAS - Malate Synthase
MAO - Monoamine Oxidase
MDH - Malate Dehydrogenase
ME1 - NADP-dependent Malic Enzyme
MeCbl(III) - Methylcobalamin
MetHb - Methemoglobinemia
Mg - Magnesium
MHPG - 3-Methoxy-4-Hydroxyphenylglycolaldehyde
MIF - Macrophage Migration Inhibitory Factor
MA - Methylmalonic Aciduria
MMAA - (Cbl)A MA Type A protein, GTPase
MMAB - (Cbl)B ATP:Cob(I)alamin Adenosyltransferase
MMACHC - (Cbl)C) MA and Homocystinuria Type C protein
MMADHC - (Cbl)D) MA and Homocystinuria Type D protein
MMC-M - MethylMalonyl-CoA Mutase
MMC-R - MethylMalonyl-CoA Racemase
MMP - Matrix Metalloproteinase
Mn - Manganese
Mo - Molybdenum
Mo-MPT - Mo-Molybdopterin
MS - Methionine Synthase
MTA - 2-Methylthioadenosine
MTHFR - MethyleneTetrahydroFolate Reductase
MTR - 3-Methoxytyramine
MTRR - Methionine Synthase Reductase
NTSC2 - Cytosolic 5'-nucleotidase II
Na - Sodium
Na+/K+-ATPase - Sodium-Potassium ATP Pump
N-Ac-Put - N-Acetyl-Putrescine
N-Ac-ABAL - N-Acetyl-Gamma-Aminobutyraldehyde
N-Ac-GABA - N-Acetyl-Gamma-Aminobutyrate
NAD - Nicotinamide Adenine Dinucleotide
NADK - NAD Kinase
NADPT - NAD(P)+ Transhydrogenase
NADSYN - NAD Synthetase
NAGK - N-Acetylglucosamine Kinase
NAM - Nicotinamide
NAMPT - Nicotinamide Phosphoribosyltransferase
NAPRT - Nicotinate Phosphoribosyltransferase
N-AS - N-Acetylspermidine
N-ASD - N-Acetylspermidine
NCS - Norcoclaurine Synthase
NDPK - Nucleoside Diphosphokinase
NET - Norepinephrine Transporter
NH_3 - Ammonia
NMNAT - Nicotinamide Mononucleotide Adenylyltransferase
NO - Nitric Oxide
NOS - Endothelial Nitric Oxide Synthase
O_2 - Oxygen
OAA - Oxaloacetate
OAADPR - 2'-O-Acetyl-ADP-Ribose
OAT - Ornithine Aminotransferase
ODC - Ornithine Decarboxylase
OH-Cobl(III)alamin - Hydroxocobalamin
OH-ENP - 4-Hydroxy-Enol-Phenylpyruvate
OH-Glut - 4-Hydroxyglutamate
OH-GlutSA - 4-Hydroxyglutamate Semialdehyde
OH-KG - 4-Hydroxy-2-Ketoglutarate
OH-P5C - Pyroline Hydroxycarboxylate
OH-PD - 4-Hydroxyphenylpyruvate Dioxygenase
OH-PH4 - 1-Hydroxy-2-Oxopropyl Tetrahydropterin
OH-PLA - Hydroxyphenyllactic Acid
OH-PPA - 4-Hydroxyphenylpyruvic Acid
OH-PPD - 4-Hydroxyphenyl-Pyruvate Dioxygenase
OH-Pyr - Hydroxypyruvate
OMP - Orotidine-5'-Monophosphate
OMPDC - OMP Decarboxylase
OPRT - Orotate Phosphoribosyltransferase
OTC - Ornithine Transcarbamoylase
OX - Oxalate
OXH - Oxaloacetase
P5C - Pyroline-5-Carboxylate
P5CR - P5C Reductase
PSP - Pyridoxal 5'-Phosphate
PAA - Phenylacetic Acid
PAcAL - Phenylacetaldehyde
PAGM - Phosphoacetylglucosamine Mutase
PAGS - Phenylacetylglutamine Synthetase
PAH - Phenylalanine Hydroxylase
PAICS,C - AIR carboxylase
PAICS,N - SAICAR synthetase
PAL - Pyruvaldehyde
PAMOAT - Pyridoxamine:Oxaloacetate Aminotransferase
PANK - Pantetheine Kinase
PAO - Polyamine Oxidase
PAP - Adenosine 3',5'-Diphosphate
PAPS - 3'-Phosphoadenosine-5'-Phosphosulfate
PAT - Phenylalanine Aminotransferase
PATK - Panthenate Kinase
PC - Phosphocreatine
PCB - Pyruvate Carboxylase
PCC - Propionyl-CoA Carboxylase
PDH - Pyruvate Dehydrogenase
PEPC - Phosphoenolpyruvate Carboxylase
PEPCK - Phosphoenolpyruvate Carboxykinase
PFAS - Phosphoribosylformylglycinamidine Synthase
PFK1 - Phosphofructokinase
PFK-2 - 6-Phosphofructo-2-Kinase
PGAM - Phosphoglycerate Mutase
PGC1α - PPARγ-gamma Coactivator 1-Alpha
PGI - Phosphoglucose Isomerase
PGK - Phosphoglycerate Kinase
PGLS - 6-Phosphogluconolactonase
PGM - Phosphoglucomutase
PHCDH - Pyroline-3-Hydroxy-5-Carboxylate Dehydrogenase
PHD - Prolyl Hydroxylase
PHGDH - Phosphoglycerate Dehydrogenase
PHT - PhenylPyruvate Tautomerase
P_i - Phosphate
PK - Pyridoxal Kinase
PKM - Pyruvate Kinase
PKA - Protein Kinase A
PKC - Protein Kinase C
PLA - Phenylactic Acid
PLD - Prolidase
PMP - Pyridoxamine 5'-Phosphate
PNMT - Phenylethanolamine N-Methyltransferase
PNP - Purine Nucleoside Phosphorylase
PNPO - Pyridoxine 5'-Phosphate Oxidase
PPA - PhenylPyruvic Acid
PPAR - Peroxisome Proliferator-Activated Receptor
PPAT - Amidophosphoribosyltransferase
PPP - Pyridoxal Phosphate Phosphatase
P_{Pi} - Pyrophosphate
PPCDC - Phosphopantothenoylcysteine Decarboxylase
PPCS - Phosphopantothenoylcysteine Synthetase
PPDC - PhenylpyruvateDecarboxylase
PPP - Triphosphate
PRA - 5-Phosphoribosylamine
PRDH - Proline Dehydrogenase
PRPP - 5-Phosphoribosyl-1-Pyrophosphate
PRPS - Phosphoribosyl Pyrophosphate Synthetase
PSP - Protein Synthesis Pathway
PS - Phosphatidyl Serine
PSAT - Phosphoserine Aminotransferase
PSPH - Phosphoserine Phosphatase
PSS - Phosphatidylserine Synthase
PTP - 6-Pyruvoyl-Tetrahydropterin
PTPS - 6-Pyruvoyl-Tetrahydropterin Synthase
Pyr - Pyruvate
Q - Ubiquinone (Coenzyme Q10)
Qu - Ubiquinol (Reduced Coenzyme Q10)
Que - Queuine
Queo - Queuosine
QRPT - Quinolinate Phosphorybosyltransferase
R1P - Ribose-1-Phosphate
R5P - Ribose-5-Phosphate
RBKS - Ribokinase
RET - Reverse Electron Transfer (Inner Mitochondrial Membrane)
RK - Riboflavin Kinase
ROS - Reactive Oxygen Species
RPE - Ribulose-5-Phosphate 3-Epimerase
RPIA - Ribose-5-Phosphate Isomerase A
Ru5P - Ribulose-5-Phosphate
S7P - Sedoheptulose-7-Phosphate
SAH - S-Adenosyl-L-Homocysteine
SAICAR - 5-Aminoimidazole-4-(N-succinylcarboxamide) Ribonucleotide
SAMe - S-Adenosylmethionine
SAMeA - S-Adenosylmethionamine
SAMeD - S-Adenosylmethionine Decarboxylase
SAMeS - S-Adenosylmethionine Synthase
SARDH - Sarcosine Dehydrogenase
SAT - Serotonin N-Acetyltransferase
SCOT - Succinyl-CoA:3-ketoacid CoA Transferase
SCS - Succinyl-CoA Synthetase
SDH - Succinate Dehydrogenase
Se - Selenium
Ser - Serine
SGLT - Serine-Glyoxylate Transaminase
SHMT - Serine Hydroxymethyltransferase
Si - Silicon
SLC - Solute Carrier
SPDS - Spermidine Synthase
SPOX - Spermine Oxidase
SPS - Spermine Synthase
SQOR - Sulfide Quinone Oxidoreductase
SR - Sepiapterin Reductase
SSAL - Succinic Semialdehyde
SSAT1 - Spermidine/Spermine-N1-Acetyltransferase
Succ - Succinate
SULTs - Sulfotransferases
SUOX - Sulfite Oxidase
T3 - Triiodothyronine
TA - Tyrosinase
TALDO1 - Transaldolase 1
TAT - Tyrosine Aminotransferase
TDC - Tyrosine Decarboxylase
TGF - Transforming Growth Factor
TGT - tRNA Guanine Transglycosylase
TH - Tyrosine Hydroxylase
ThDP - Thiamine Diphosphate
THF - Tetrahydrofolate
THL - Thiolase
THP - Tetrahydropapaveroline
TKT - Transketolase
TMLH - Trimethyllysine Hydroxylase
TNF - Tumour Necrosis Factor
TPH - Tryptophan Hydroxylase
TPI - Triose Phosphate Isomerase
TPP - Thiamine Pyrophosphate
TPQ - Topaquinone
TS - Thymidylate Synthase
TST - Thiosulfate Sulfurtransferase
UCK - Uridine-Cytidine Kinase
UDP - Uridine Diphosphate
UGPase - UDP-Glucose Pyrophosphorylase
UGAPase - UDP-GlcNAc Pyrophosphorylase
UMP - Uridine Monophosphate
UPP - Uridine Phosphorylase
UROC - Urocanase
UTP - Uridine Triphosphate
V - Vanadium
V-ATPase - Vesicular H+-ATP Pump
Vit C - Ascorbic Acid
Vit E - Tocopherols, Tocotrienols
VMA - Vanillylmandelic Acid
VMAT - Vesicular Monoamine Transporter
VNN - Vanin-1 (Pantetheinase)
XO - Xanthine Oxidase
Xu5P - Xylulose-5-Phosphate
Zn - Zinc

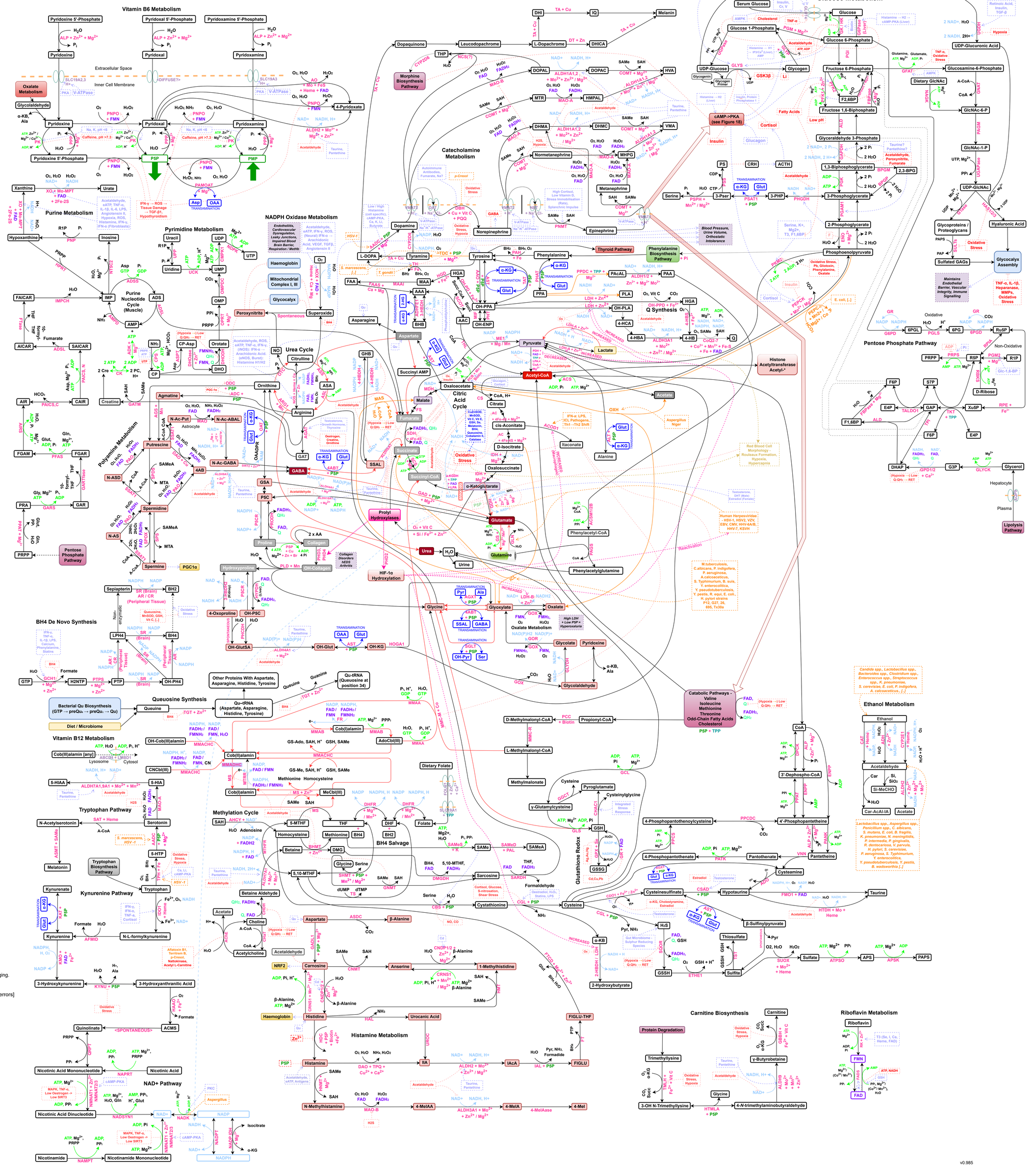

Figure 1. Pathway Diagram: The role of mitochondrial dysfunction in chronic disease and aging.

ME/CFS: Correcting Chronic Mitochondrial Dysfunction

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COLOUR KEY (Labels)

ATP, ADP, AMP, GTP, GDP
TPP
FAD, FMN
NAD+, NADH, NADP, NADPH
P5P
Q, QH₂
REACTION
TRANSAMINATION
TRANSPORTERS
MICROBIAL / PATHOGENIC
PROMOTER
INHIBITOR
(Others - Illustrative)

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