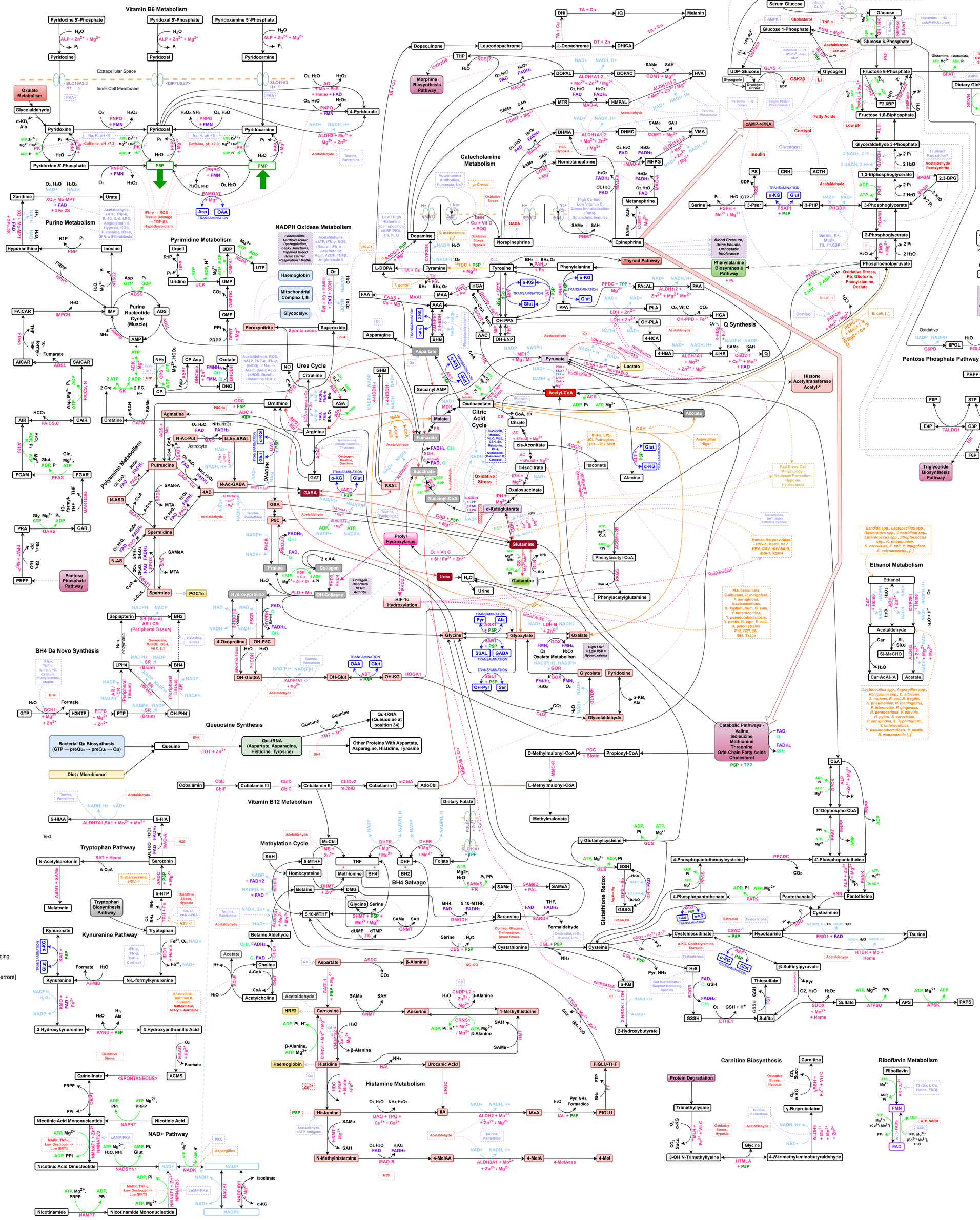

2-HG - 2-Hydroxyglutarate
3-PHP - 3-Phosphate Hydroxypyruvate
3-Pser - 3-Phosphoserine
4AB - 4-Aminobutyraldehyde
4ABT - 4-Aminobutyrate Transaminase
4Fe-4S - Tetrakis(λ³-oxoto(1+) ion) Tetrasulfane Tetrasulfanide
4-HB - 4-Hydroxybenzoic Acid
4-HBA - 4-Hydroxybenzaldehyde
4-HBS - 4-Hydroxybenzoate Synthase
4-HCA - 4-Hydroxycinnamic Acid
4-Mel - 4-Methylimidazole
4-MeIA - Methylimidazole Acetate
4-MeIAas - Methylimidazole Acetate Hydrolase
5-HIA - 5-Hydroxyindoleacetate 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
AADC - Aromatic L-Amino Acid Decarboxylase
AAO - L-Amino-Acid Oxidase
AC - Acetylase
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
ACOD - 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 - Adenosylcobalam
ADP - Adenosine Diphosphate
ADS - Adenylosuccinate
ADSL - Adenylsuccinate Lyase
ADSS - Adenylosuccinate Synthetase
AFMID - Kynurenine Formamidase
AGAT - Arginine:Glycine Amidinotransferase
AGXT - Alanine-Glyoxylate Aminotransferase
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
ASA - Argininosuccinate
ASDC - Aspartate Decarboxylase
ASL - Argininosuccinate Lyase
Asp - Aspartate
ASPT - Aspartate Transcarbamoylase
ASS - Argininosuccinate Synthetase
AST - Aspartate Aminotransferase
ASMT - Acetylserotonin O-Methyltransferase
ATP - Adenosine Triphosphate
BH₂ - Dihydrobiopterin
BH₄ - 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-AcAl-IA - Carnosine-Acetaldehyde-Imidazolidinone 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
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
CO₂ - Carbon Dioxide
Co - Cobalt
CoA - Coenzyme A
CoAH - CoA Hydrolase
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
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-Biphosphate
F2,6BP - Fructose 2,6-Biphosphate
F6P - Fructose-6-Phosphate
FAA - 4-Fumarylacetoacetic Acid
FAAS - Fumarylacetoacetase
FAD - Adeflavin
FADS - FAD Synthetase
FAICAR - 5-Formamidoimidazole-4-Carboxamide Ribonucleotide
FBPase - Fructose 1,6-Biphosphatase
FBPase2 - Fructose 2,6-Biphosphatase
Fe - Ferritin
FGAM - Formylglycinamidine Ribonucleotide
FGAR - Formylglycinamide Ribonucleotide
FIGLU - Formimidylglutamic Acid
FIGLU-THF - Formiminoglutamate-THF
FMN - Flavin Mononucleotide
FMO - Flavin Monooxygenase
FOLH - Folate Hydrotase
FS - Fumarase
FT - Formiminotransferas
FTase - AICAR Transformylase
FTCD - Formiminotransferase Cyclodeaminase
G3P - Glyceraldehyde-3-Phosphate
G6Pase - Glucose 6-Phosphotase
G6PD - Glucose-6-Phosphate Dehydrogenase
GABA - Gamma-Aminobutyric Acid
GAD - Glutamate Decarboxylase
GAG - Glycosaminoglycan
GAMT - S-Adenosylmethionine:Guanidinoacetate Methyltransferase
GAPDH - Glyceraldehyde 3-Phosphate Dehydrogenase
GARS - GAR Synthetase
GARTase - GAR Transformylase
GAT - Guanidinoacetate
γBBH - γ-Butyrobetaine Hydroxylase
GCA - γ-Glutamylcysteine Synthase
GCH1 - GTP Cyclohydrolase I
GDP - Guanosine Diphosphate
GDH - Glutamate Dehydrogenase
GFAT - Glutamine:Fructose-6P Amidotransferase
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 - Glutamaine
GLS - Glutathione Synthase
GLSH - Glutamate Dehydrogenase
Gly - Glycine
GLYDH - Glycolaldehyde Dehydrogenase
GLYP - Glycogen Phosphorylase
GLYS - Glycogen Synthase
Glut - Glutamate
GNMT - Glycine N-Methyltransferase
GOR - Glyoxylate Reductase
GOX - Glycolate Oxidase
GPX - Glutathione Peroxidase
GR - Glutathione Reductase
GS - Glutamine Synthetase
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
H₂O - Water
H₂O₂ - Hydrogen Peroxide
H2S - Hydrogen Sulfide
H2NTP - 7,8-Dihydroneopterin Triphosphate
HAAO - 3-Hydroxyanthranilic Acid Dioxygenase
HAL - Histidine Ammonia-Lyase
HAS - Hyaluronic Acid Synthase
HBDH - Hydroxybutyrate Dehydrogenase
HCO₃ - 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
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 - Methylcobalamin
MetHb - Methemoglobinemia
Mg - Magnesium
MHPG - 3-Methoxy-4-Hydroxyphenylglycolaldehyde
MIF - Macrophage Migration Inhibitory Factor
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 - 5′-Methylthioadenosine
MTHFR - MethyleneTetraHydroFolate Reductase
MTR - 3-Methoxytyramine
NTSC2 - Cytosolic 5′-nucleotidase II
Na - Sodium
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-Acetylspermine
N-ASD - N-Acetylspermidine
NCS - Norcoclaurine Synthase
NDPK - Nucleoside Diphosphokinase
NET - Norepinephrine Transporter
NH₃ - Ammonia
NMNAT - Nicotinamide Mononucleotide Adenylyltransferase
NO - Nitric Oxide
NOS - Endothelial Nitric Oxide Synthase
Ox - Oxygen
OAA - Oxaloacetate
ODC - Ornithine Decarboxylase
OPRT - Orotate Phosphoribosyltransferase
OTC - Ornithine Transcarbamoylase
OX - Oxalate
OXH - Oxaloacetase
PSC - Pyrroline-5-Carboxylate
P5CR - P5C Reductase
P5P - 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
PFK 1 - 6-Phosphofructo-1-Kinase
PFK 2 - 6-Phosphofructo-2-Kinase
PGAM - Phosphoglycerate Mutase
PGC1α - PPAR-gamma Coactivator 1-Alpha
PGI - Phosphoglucose Isomerase
PGK - Phosphoglycerate Kinase
PGLS - 6-Phosphogluconolactonase
PGM - Phosphoglucomutase
PHCDH - Pyrroline-3-hydroxy-5-carboxylate Dehydrogenase
PHD - Prolyl Hydroxylase
PHGDH - Phosphoglycerate Dehydrogenase
PHT - Phenylpyruvate Tautomerase
Pi - 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
PPi - Pyrophosphate
PPCDC - Phosphopantothenoylcysteine Decarboxylase
PPCS - Phosphopantothenoylcysteine Synthetase
PPDC - Phenylpyruvate Decarboxylase
PQQ - Pyroloquinoline Quinone
PRA - 5-Phosphoribosylamine
PRODH - 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)
Qu - Quinuine
Qus - Queuosine
QRPT - Quinolinate Phosphoryborsyltransferase
R1P - Ribose-1-Phosphate
R5P - Ribose-5-Phosphate
RBK5 - Ribokinase
RK - Riboflavin Kinase
ROS - Reactive Oxygen Species
RPE - Ribulose-5-Phosphate 3-Epimerase
RPIA - Ribose-5-Phosphate Isomerase A
RuSP - 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 - Sulfite 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
Vit C - Ascorbic Acid
Vit E - Tocopherols, Tocotrienols
VMA - Vanillymandelic 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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