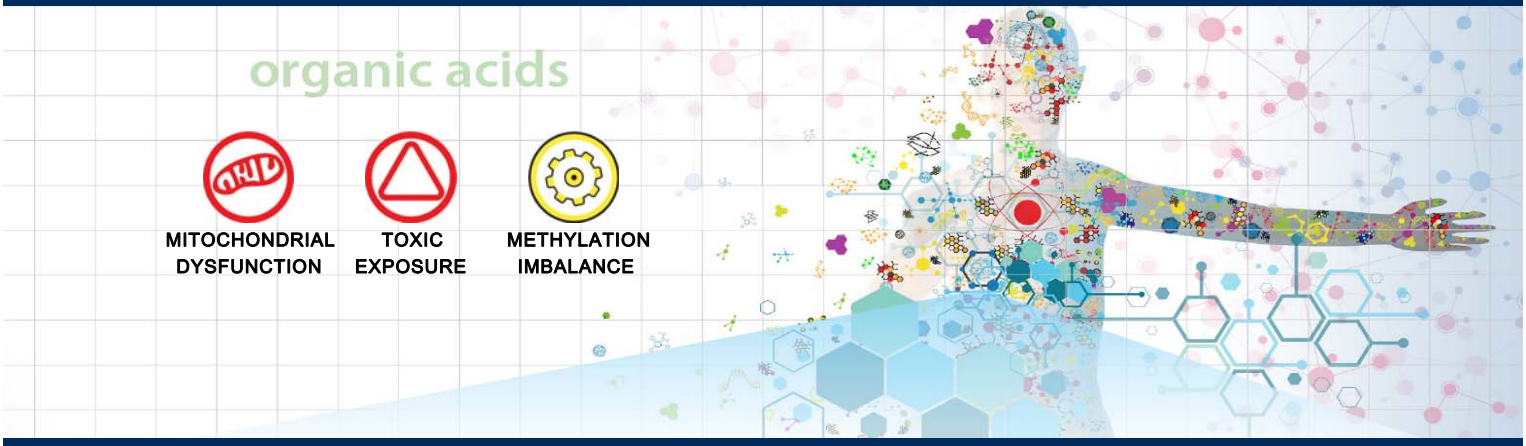
GENOVA DIAGNOSTICS
63 Zillicoa Street
Asheville, NC 28801

Organic Acids
NUTRITIONAL

Patient: **SAMPLE PATIENT**
DOB:
Sex:
MRN:

3300 Organic Acids - Urine

Results Overview



Functional Imbalance Scores

Key 0-4 : Minimal Need for Support | 5-7 : Moderate Need for Support | 8-10 : High Need for Support

Need for Mitochondrial Support

Mitochondrial Dysfunction

8

FIGLU	●
Methylmalonic Acid	▲
Glutaric Acid	▲
Lactic Acid	●
Pyruvic Acid	●
Citric Acid	▲
cis-Aconitic Acid	▲
Isocitric Acid	▲
α-Ketoglutaric Acid	▲
Succinic Acid	△
Malic Acid	▲
Adipic Acid	●
Suberic Acid	▲

Need for Reduced Exposure

Toxic Exposure

8

α-Hydroxyisobutyric Acid	▲
α-Ketophenylacetic Acid	△
Pyroglutamic Acid	▲
Orotic Acid	△
Citric Acid	▲
cis-Aconitic Acid	▲
Isocitric Acid	▲
Glutaric Acid	▲

Need for Methylation Support

Methylation Imbalance

7

Methylmalonic Acid	▲
FIGLU	●
Vanilmandelic Acid	▲
Creatinine	●

Nutrient Need Overview

	Nutrient Need (0 1 2 3 4 5 6 7 8 9 10)	DRI	Suggested Recommendations	Provider Recommendations
Antioxidants				
Glutathione				
B-Vitamins				
Thiamin - B1		1.1 mg	25 mg	
Riboflavin - B2		1.1 mg	50 mg	
Niacin - B3		14 mg	50 mg	
Pyridoxine - B6		1.3 mg	25 mg	
Biotin - B7		30 mcg	400 mcg	
Folate - B9		400 mcg	800 mcg	
Cobalamin - B12		2.4 mcg	1,000 mcg	
Minerals				
Magnesium		320 mg	800 mg	
Manganese		1.8 mg	5.0 mg	
Zinc		8 mg	10 mg	
GI Support				
Digestive Support/Enzymes			10,000 IU	
Microbiome Support/Probiotics			50 billion CFU	

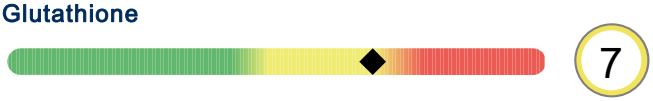
Recommendations for age and gender-specific supplementation are set by comparing levels of nutrient functional need to optimal levels as described in the peer-reviewed literature. They are provided as guidance for short-term support of nutritional deficiencies only.

The Nutrient Need Overview is provided at the request of the ordering practitioner. Any application of it as a therapeutic intervention is to be determined by the ordering practitioner.

Interpretation At-A-Glance

Antioxidant Needs

Glutathione



- Glutathione (GSH) is composed of cysteine, glutamine & glycine. GSH is a source of sulfate and plays a key role in antioxidant activity and detoxification of toxins.
- GSH requirement is increased with high-fat diets, cigarette smoke, cystinuria, chronic alcoholism, chronic acetaminophen use, infection, inflammation and toxic exposure.
- Deficiency may result in oxidative stress & damage, impaired detoxification, altered immunity, macular degeneration and increased risk of chronic illness.
- Food sources of GSH precursors include meats, poultry, fish, soy, corn, nuts, seeds, wheat germ, milk and cheese.

KEY

Function of Nutrient | Cause of Deficiency | Complications of Deficiency | Food Sources of Nutrient

Interpretation At-A-Glance

B-Vitamin Needs

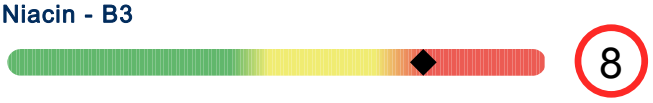
Thiamin - B1

- B1 is a required cofactor for enzymes involved in energy production from food, and for the synthesis of ATP, GTP, DNA, RNA and NADPH.
- Low B1 can result from chronic alcoholism, diuretics, digoxin, oral contraceptives and HRT, or large amounts of tea & coffee (contain anti-B1 factors).
- B1 deficiency may lead to dry beriberi (e.g., neuropathy, muscle weakness), wet beriberi (e.g., cardiac problems, edema), encephalopathy or dementia.
- Food sources include lentils, whole grains, wheat germ, Brazil nuts, peas, organ meats, brewer's yeast, blackstrap molasses, spinach, milk & eggs.

Riboflavin - B2

- B2 is a key component of enzymes involved in antioxidant function, energy production, detoxification, methionine metabolism and vitamin activation.
- Low B2 may result from chronic alcoholism, some anti-psychotic medications, oral contraceptives, tricyclic antidepressants, quinacrine or adriamycin.
- B2 deficiency may result in oxidative stress, mitochondrial dysfunction, low uric acid, low B3 or B6, high homocysteine, anemia or oral & throat inflammation.
- Food sources include milk, cheese, eggs, whole grains, beef, chicken, wheat germ, fish, broccoli, asparagus, spinach, mushrooms and almonds.

Niacin - B3



- B3 is used to form NAD and NADP, involved in energy production from food, fatty acid & cholesterol synthesis, cell signaling, DNA repair & cell differentiation.
- Low B3 may result from deficiencies of tryptophan (B3 precursor), B6, B2 or Fe (cofactors in B3 production), or from long-term isoniazid or oral contraceptive use.
- B3 deficiency may result in pellagra (dermatitis, diarrhea, dementia), neurologic symptoms (e.g., depression, memory loss), bright red tongue or fatigue.
- Food sources include poultry, beef, organ meats, fish, whole grains, peanuts, seeds, lentils, brewer's yeast and lima beans.

Pyridoxine - B6

- B6 (as P5P) is a cofactor for enzymes involved in glycogenolysis & gluconeogenesis, and synthesis of neurotransmitters, heme, B3, RBCs and nucleic acids.
- Low B6 may result from chronic alcoholism, long-term diuretics, estrogens (oral contraceptives and HRT), anti-TB meds, penicillamine, L-DOPA or digoxin.
- B6 deficiency may result in neurologic symptoms (e.g., irritability, depression, seizures), oral inflammation, impaired immunity or increased homocysteine.
- Food sources include poultry, beef, beef liver, fish, whole grains, wheat germ, soybean, lentils, nuts & seeds, potato, spinach and carrots.

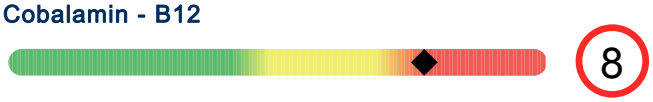
Biotin - B7

- Biotin is a cofactor for enzymes involved in functions such as fatty acid synthesis, mitochondrial FA oxidation, gluconeogenesis and DNA replication & transcription.
- Deficiency may result from certain inborn errors, chronic intake of raw egg whites, long-term TPN, anticonvulsants, high-dose B5, sulfa drugs & other antibiotics.
- Low levels may result in neurologic symptoms (e.g., paresthesias, depression), hair loss, scaly rash on face or genitals or impaired immunity.
- Food sources include yeast, whole grains, wheat germ, eggs, cheese, liver, meats, fish, wheat, nuts & seeds, avocado, raspberries, sweet potato and cauliflower.

Folate - B9

- Folate plays a key role in coenzymes involved in DNA and SAMe synthesis, methylation, nucleic acids & amino acid metabolism and RBC production.
- Low folate may result from alcoholism, high-dose NSAIDs, diabetic meds, H2 blockers, some diuretics and anti-convulsants, SSRIs, methotrexate, trimethoprim, pyrimethamine, triamterene, sulfasalazine or cholestyramine.
- Folate deficiency can result in anemia, fatigue, low methionine, increased homocysteine, impaired immunity, heart disease, birth defects and CA risk.
- Food sources include fortified grains, green vegetables, beans & legumes.

Cobalamin - B12



- B12 plays important roles in energy production from fats & proteins, methylation, synthesis of hemoglobin & RBCs, and maintenance of nerve cells, DNA & RNA.
- Low B12 may result from alcoholism, malabsorption, hypochlorhydria (e.g., from atrophic gastritis, H. pylori infection, pernicious anemia, H2 blockers, PPIs), vegan diets, diabetic meds, cholestyramine, chloramphenicol, neomycin or colchicine.
- B12 deficiency can lead to anemia, fatigue, neurologic symptoms (e.g., paresthesias, memory loss, depression, dementia), methylation defects or chromosome breaks.
- Food sources include shellfish, red meat, poultry, fish, eggs, milk and cheese.

KEY

Function of Nutrient | Cause of Deficiency | Complications of Deficiency | Food Sources of Nutrient

Interpretation At-A-Glance

Mineral Needs

Magnesium

- Magnesium is involved in >300 metabolic reactions. Key areas include energy production, bone & ATP formation, muscle & nerve conduction and cell signaling.
- Deficiency may occur with malabsorption, alcoholism, hyperparathyroidism, renal disorders (wasting), diabetes, diuretics, digoxin or high doses of zinc.
- Low Mg may result in muscle weakness/spasm, constipation, depression, hypertension, arrhythmias, hypocalcemia, hypokalemia or personality changes.
- Food sources include dark leafy greens, oatmeal, buckwheat, unpolished grains, chocolate, milk, nuts & seeds, lima beans and molasses.

Manganese

- Manganese plays an important role in antioxidant function, gluconeogenesis, the urea cycle, cartilage & bone formation, energy production and digestion.
- Impaired absorption of Mn may occur with excess intake of Fe, Ca, Cu, folic acid, or phosphorous compounds, or use of long-term TPN, Mg-containing antacids or laxatives.
- Deficiency may result in impaired bone/connective tissue growth, glucose & lipid dysregulation, infertility, oxidative stress, inflammation or hyperammonemia.
- Food sources include whole grains, legumes, dried fruits, nuts, dark green leafy vegetables, liver, kidney and tea.

Zinc

- Zinc plays a vital role in immunity, protein metabolism, heme synthesis, growth & development, reproduction, digestion and antioxidant function.
- Low levels may occur with malabsorption, alcoholism, chronic diarrhea, diabetes, excess Cu or Fe, diuretics, ACE inhibitors, H2 blockers or digoxin.
- Deficiency can result in hair loss and skin rashes, also impairments in growth & healing, immunity, sexual function, taste & smell and digestion.
- Food sources include oysters, organ meats, soybean, wheat germ, seeds, nuts, red meat, chicken, herring, milk, yeast, leafy and root vegetables.

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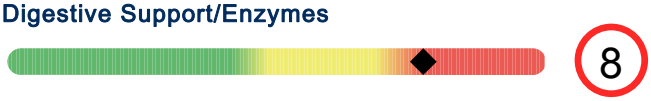
Interpretation At-A-Glance

Microbiome & Digestive Support

Microbiome Support/Probiotics

- Probiotics have many functions. These include: production of some B vitamins and vitamin K; enhance digestion & absorption; decrease severity of diarrheal illness; modulate of immune function & intestinal permeability.
- Alterations of gastrointestinal microflora may result from C-section delivery, antibiotic use, improved sanitation, decreased consumption of fermented foods and use of certain drugs.
- Some of the diseases associated with microflora imbalances include: IBS, IBD, fibromyalgia, chronic fatigue syndrome, obesity, atopic illness, colic and cancer.
- Food sources rich in probiotics are yogurt, kefir and fermented foods.

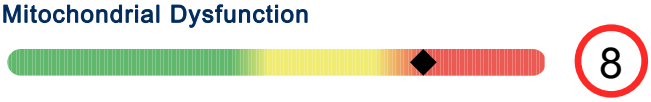
Digestive Support/Enzymes



- Pancreatic enzymes are secreted by the exocrine glands of the pancreas and include protease/peptidase, lipase and amylase.
- Pancreatic exocrine insufficiency may be primary or secondary in nature. Any indication of insufficiency warrants further evaluation for underlying cause (i.e., celiac disease, small intestine villous atrophy, small bowel bacterial overgrowth).
- A high functional need for digestive enzymes suggests that there is an impairment related to digestive capacity.
- Determining the strength of the pancreatic enzyme support depends on the degree of functional impairment. Supplement potency is based on the lipase units present in both prescriptive and non-prescriptive agents.

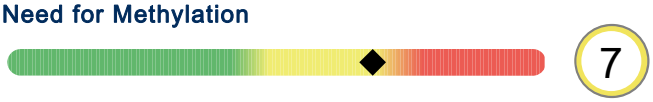
Functional Imbalances

Mitochondrial Dysfunction



- Mitochondria are a primary site of generation of reactive oxygen species. Oxidative damage is considered an important factor in decline of physiologic function that occurs with aging and stress.
- Mitochondrial defects have been identified in cardiovascular disease, fatigue syndromes, neurologic disorders such as Parkinson's and Alzheimer's disease, as well as a variety of genetic conditions. Common nutritional deficiencies can impair mitochondrial efficiency.

Need for Methylation



- Methylation is an enzymatic process that is critical for both synthesis and inactivation. DNA, estrogen and neurotransmitter metabolism are all dependent on appropriate methylation activity.
- B vitamins and other nutrients (methionine, magnesium, selenium) functionally support catechol-O-methyltransferase (COMT), the enzyme responsible for methylation.

Toxic Exposure

- Methyl tert-Butyl Ether (MTBE) is a common gasoline additive used to increase octane ratings, and has been found to contaminate ground water supplies where gasoline is stored. Inhalation of MTBE may cause nose and throat irritation, as well as headaches, nausea, dizziness and mental confusion. Animal studies suggest that drinking MTBE may cause gastrointestinal irritation, liver and kidney damage and nervous system effects.
- Styrene is classified by the US EPA as a "potential human carcinogen," and is found widely distributed in commercial products such as rubber, plastic, insulation, fiberglass, pipes, food containers and carpet backing.
- Levels of these toxic substances should be examined within the context of the body's functional capacity for methylation and need for glutathione.

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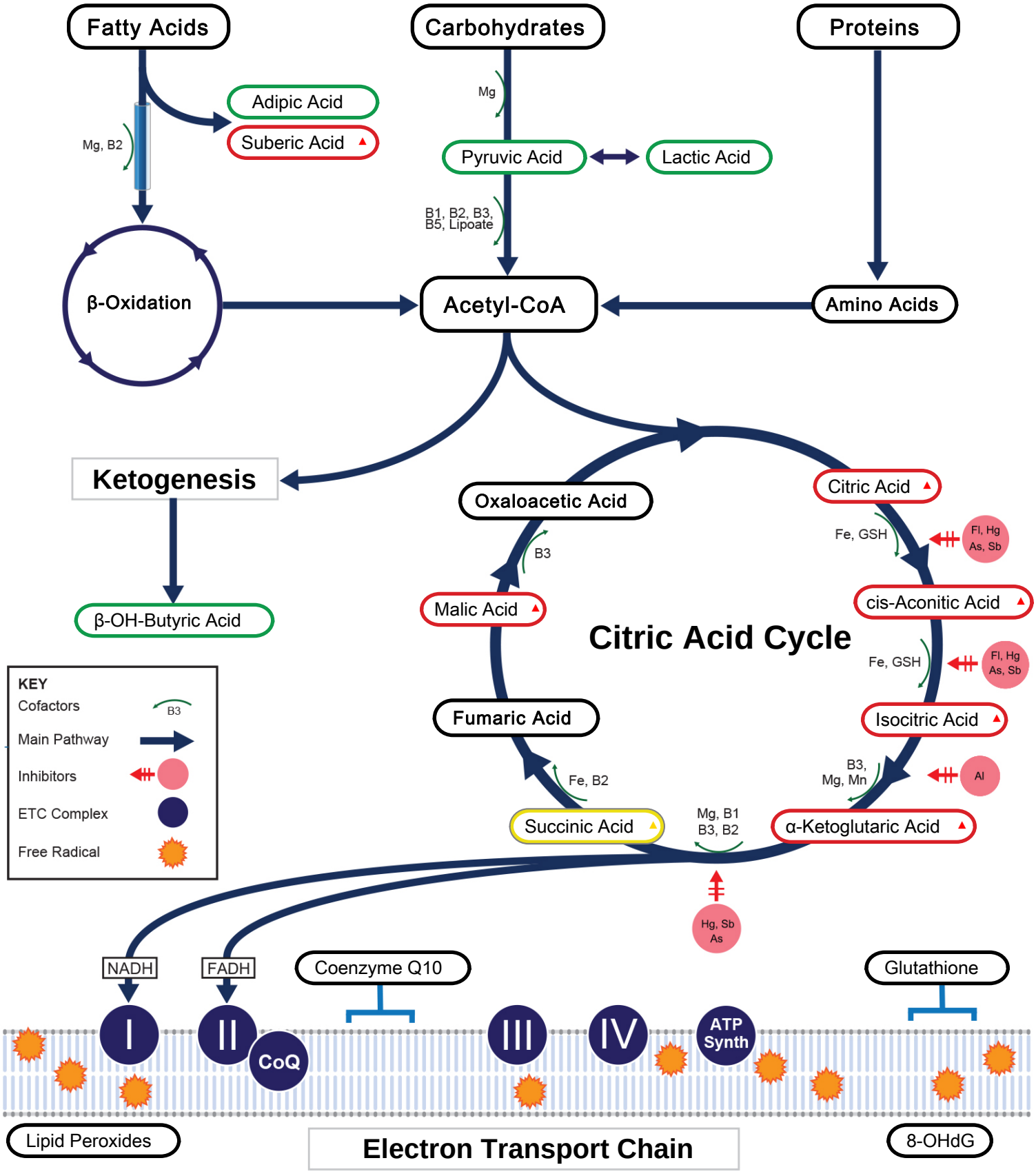
Oxidative Stress & Mitochondrial Dysfunction



All biomarkers reported in mmol/mol creatinine unless otherwise noted.

Organic Acids

Malabsorption & Dysbiosis Markers

Malabsorption Markers

		Reference Range
Indoleacetic Acid	40.0	<= 4.2
Phenylacetic Acid	<dl	<= 0.12

Dysbiosis Markers

		Reference Range
Dihydroxyphenylpropionic Acid (DHPPA)	18.9	<= 5.3
3-Hydroxyphenylacetic Acid	5.8	<= 8.1
4-Hydroxyphenylacetic Acid	19	<= 29
Benzoic Acid	0.10	<= 0.05
Hippuric Acid	340	<= 603

Yeast / Fungal Dysbiosis Markers

D-Arabinitol	14	<= 36
Citramalic Acid	2.6	<= 5.8
Tartaric Acid	5	<= 15

Vitamin Markers

Branched-Chain Catabolites (B1, B2, B3, ALA)

		Reference Range
α-Ketoadipic Acid	1.9	<= 1.7
α-Ketoisovaleric Acid	<dl	<= 0.97
α-Ketoisocaproic Acid	<dl	<= 0.89
α-Keto-β-Methylvaleric Acid	<dl	<= 2.1
Glutaric Acid	0.97	<= 0.51
Isovalerylglycine	1.8	<= 3.7

Methylation Markers (Folate, B12)

Formiminoglutamic Acid (FIGlu)	0.6	<= 1.5
Methylmalonic Acid	2.7	<= 1.9

Biotin Markers

3-Hydroxypropionic Acid	15	5-22
3-Hydroxyisovaleric Acid	25	<= 29

Cellular Energy & Mitochondrial Markers

Fatty Acid Metabolism

		Reference Range
Adipic Acid	1.3	<= 2.8
Suberic Acid	2.5	<= 2.1

Carbohydrate Metabolism

Pyruvic Acid	21	7-32
Lactic Acid	10.8	1.9-19.8
α-Hydroxybutyric Acid	0.70	<= 0.83
β-OH-Butyric Acid	1.4	<= 2.8
β-OH-β-Methylglutaric Acid	9	<= 15

Energy Metabolism

Citric Acid	760	40-520
cis-Aconitic Acid	50	10-36
Isocitric Acid	100	22-65
α-Ketoglutaric Acid	100	4-52
Succinic Acid	3.7	0.4-4.6
Malic Acid	3.2	<= 3.0

Neurotransmitter Metabolites

Kynurenine Markers (Vitamin B6)

		Reference Range
Kynurenic Acid	8.7	<= 7.1
Quinolinic Acid	4.2	<= 9.1
Kynurenic / Quinolinic Ratio	2.07	>= 0.44
Xanthurenic Acid	0.59	<= 0.96

Catecholamine Markers

Homovanillic Acid	14.7	1.2-5.3
Vanilmandelic Acid	4.2	0.4-3.6
3-Methyl-4-OH-phenylglycol	0.13	0.02-0.22

Serotonin Markers

5-OH-indoleacetic Acid	24.2	3.8-12.1

Toxin & Detoxification Markers

		Reference Range
Pyroglutamic Acid	68	16-34
α-Ketophenylacetic Acid (from Styrene)	0.33	<= 0.46
α-Hydroxyisobutyric Acid (from MTBE)	7.5	<= 6.7
Orotic Acid	0.81	0.33-1.01

Methodology: GCMS, LC/MS/MS, Alkaline Picrate, Colorimetric

Organic Acid Reference Ranges are Age Specific

Methodology: Colorimetric, thiobarbituric acid reactive substances (TBARS), Alkaline Picrate, Hexokinase/G-6-PDH, HPLC, GC/MS

Organic Acids

Oxalate Markers

		Reference Range
Glyceric Acid	16.0	3.5-16.4
Glycolic Acid	25	<= 67
Oxalic Acid	24	<= 78

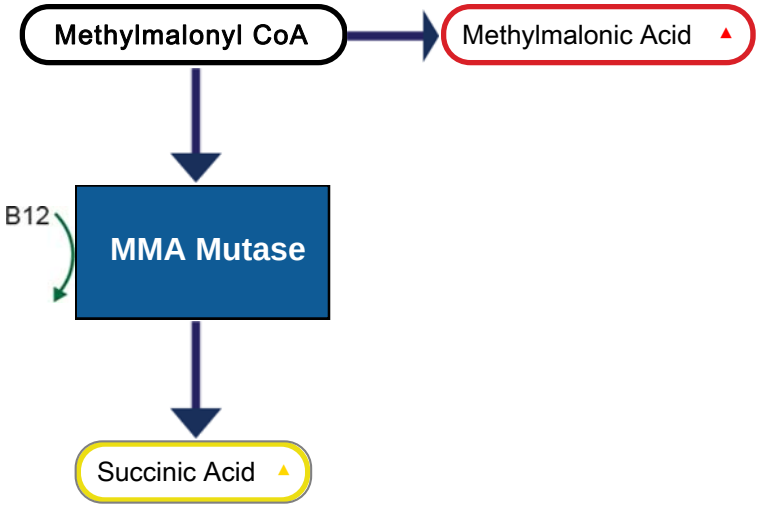
All biomarkers reported in mmol/mol creatinine.

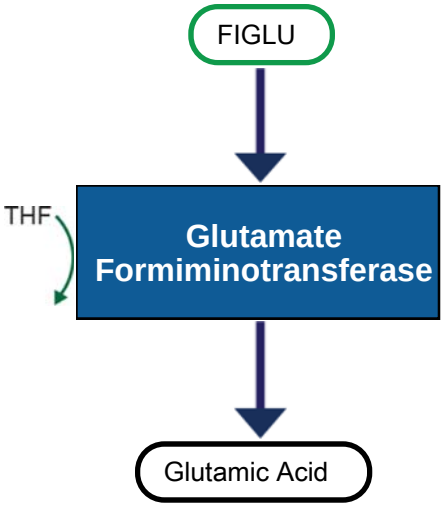
Creatinine Concentration

		Reference Range
Creatinine ◆	4.1	3.1-19.5 mmol/L

Pathways

Methylation Markers





Branch-Chain Amino Acid Metabolism