Urinary Metabolic Profile Quick Reference Guide

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Analyte	Cofactor / Nutrient Associations[1]	Clinical Considerations
Glycolysis Metabolites		
Pyruvate Anaerobic breakdown product of glucose	• Alpha Lipoic acid • B-Complex • CoQ10 • Manganese	•Salicylate toxicity • Vigorous exercise • Inefficient acquisition into CAC (Citric Acid Cycle) • Tissues under limiting O_2 conditions (asthma, infection, trauma) • Lactic acidosis (apnea, anemia, seizure, respiratory/cardiac insufficiency) • Ketoacidosis (alcohol intake, dieting abuse, vomiting, high fat diet, uncontrolled diabetes)
Lactate Anaerobic breakdown product of pyruvate when there is insufficient O_2 to support pyruvate entry into CAC	• Alpha Lipoic acid • B-Complex (B3) • CoQ10	As Pyruvate • Acid/base imbalance
Citric Acid Cycle (CAC) Metabolites Aerobic intermediates of the Citric Acid Cycle. Fuel molecules - amino acids, fatty acids and carbohydrates enter this cycle through Acetyl-CoA to generate cellular energy		
Citrate	• Alpha Lipoic acid • L-Arginine • Aspartic acid (if Low) • B complex • GSH • Manganese	• GSH deficiency • Hyperparathyroidism • High carbohydrate or citrate intake • Inefficient cycling of CAC & mitochondrial energy production • Excessive fatigue/weakness
Cis-Aconitate	• Alpha Lipoic acid • Aspartic acid (if Low) • L-Cysteine • B Complex • GSH • Manganese	As Citrate
Isocitrate	• Alpha-Ketoglutarate • Alpha Lipoic acid • Aspartic acid (if Low) • B-Complex (B3) • GSH • Manganese	As Citrate
Alpha-Ketoglutarate	• Alpha-Ketoglutarate (if Low) • Alpha Lipoic acid • L-Arginine (if low) • B-Complex • L-Glutamine	• Megaloblastic anemia • Uremia • Insulin resistance (if Low) • Diabetes mellitus (if Low) • Excessive fatigue/weakness • Inefficient cycling of CAC & mitochondrial energy production
Succinate	• CoQ10 • B Complex (B2) • L-Isoleucine (if Low) • L- Valine (if Low)	• Tissue ischemia/poor oxygenation • Ketosis • Inefficient cycling of CAC & mitochondrial energy production • Excessive fatigue/weakness
Fumarate	• CoQ10 • B complex (B2, B3) • L-Tyrosine (if low) • L-Phenylalanine (if Low)	• Insulin resistance (if Low) • Inefficient cycling of CAC & mitochondrial energy production
Malate	• CoQ10 • B Complex (B3)	As Fumarate • Uremia

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Fatty Acid Oxidation - Products of incomplete fatty acid oxidation (omega - oxidation)		
Suberate	• CoQ10 • Choline • L-Carnitine	• Ketosis • Lactic acidosis • Liver disease • Compromised Beta-oxidation • Respiratory chain insufficiency • Intake of medium chain triglycerides (coconut oil) • Salicylic acid/ Acetaminophen/Valproic acid (VPA) use • Weakness, Fatigue, Nausea • Hypoglycemia • Recurrent infections • Fructose intolerance • Fever • Fasting • Malnutrition • Serious illness
Adipate	As Suberate	As Suberate • Jell-O® intake
Ethylmalonate	• Magnesium	As Suberate
Methylsuccinate		
Ketone Metabolites - Ketone bodies formed from fatty acids for cellular energy in conditions of impaired glucose oxidation		
Alpha-Hydroxybutyrate	• Biotin • Vitamin B12 • N-Acetylcysteine • Glycine • Folate • Vitamin B6 • Chromium • Vanadium • Alpha Lipoic Acid	• Lactic acidosis • Fructose intolerance • Respiratory chain insufficiency • Inefficient mobilization of carbohydrate stores & aerobic cycling • Oxidative stress increasing demand for glutathione • Methionine malabsorption • Vigorous exercise • Protein malnutrition • Ketosis
Beta-Hydroxybutyrate	• Biotin • Vitamin B12 • Chromium • Vanadium	As Alpha-Hydroxybutyrate • Pulmonary infection • Viral gastroenteritis • Hyperthyroidism • Vitamin B12 deficiency
Markers for Cofactor Need		
Alpha-Ketoisovalerate Branched Chain Amino Acid Catabolism (Valine) utilized in muscle tissue for energy production	• Alpha Lipoic acid • B-Complex • Magnesium	• Lactic acidosis • Ketosis
Alpha-Ketoisocaproate Branched Chain Amino Acid Catabolism (Leucine) utilized in muscle tissue for energy production	• Alpha Lipoic acid • B-Complex	As Alpha-Ketoisovalerate
Alpha-Keto-Beta-Methylvalerate Branched Chain Amino Acid Catabolism (Isoleucine) utilized in muscle tissue for energy production	• Alpha Lipoic acid • B-Complex	As Alpha-Ketoisovalerate
Beta-Hydroxyisovalerate Branched Chain Amino Acid Catabolism (Leucine) utilized in muscle tissue for energy production	• Biotin • Magnesium	• Ketosis • Protein malnutrition • Biotin deficiency (alopecia, eczema/seborrheic/candida dermatitis, immune deficiencies, muscle weakness) • Antibiotic overuse destroying biotin-producing microorganisms in gut • Long-term anticonvulsant therapy (VPA)
Methylmalonate • Branch Chain Amino Acid Catabolism (Valine) • Common pathway of Branch Chain Amino Acids into CAC	• Vitamin B12	• Pernicious anemia • Vitamin B12 deficiency
Kynurenate Amino Acid Catabolism (Tryptophan)	• Vitamin B6	• Vitamin B3 deficiency • Vitamin B6 deficiency • Disease states of excess estrogens (if Low) • Neurological disorders
Hydroxymethylglutarate • CoQ10 Synthesis • Catabolism of Leucine • Precursor of Cholesterol • Synthesis of Ketone Bodies	• CoQ10 • Vitamin B6	• Ketosis • Cholesterol lowering drugs (HMG-CoA reductase inhibitors) • Gastrointestinal yeast overgrowth

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Markers of Neurotransmitter Metabolism		
Homovanillate Catecholamine Catabolism (Dopamine)	• Ascorbic acid • Folic acid • L-Tyrosine • Iron • Copper • B Complex (B2, B3)	• Ganglioblastoma • L-Dopa medication • Fatigue • Neuroblastoma • Anxiety, Depression, Insomnia • Pheochromocytoma • Excess cholinergic stimulation from chronic stress
Vanilmandelate Catecholamine Catabolism (Epinephrine, Norepinephrine)	• Magnesium As Homovanillate	As Homovanillate • Carcinoid tumor • Catecholamine-containing foods (banana)
5-Hydroxyindoleacetate Serotonin Catabolism	• 5-Hydroxytryptophan • Vitamin B6 • Folate	• Celiac disease • Alcohol intake • SSRI drugs • Fatigue • Whipple's disease • Oat cell carcinoma of the bronchus • Carcinoid syndrome • Constipation (if Low) • Diet (avocado, banana, plum, pineapple, walnut, turkey, tomato) • Mood disorders, Anxiety, Depression, Insomnia (if Low)
Quinolinate Metabolite of tryptophan in the kynurenine pathway. This pathway is chiefly activated by IFN-gamma and IFN-alpha. Quinolinate is markedly elevated in the CNS following trauma or inflammation.	• Antioxidants	• Autoimmune condition • Chronic fatigue • Phthalate exposure • Inflammatory bowel condition • Chronic inflammation from bacterial/viral/fungal/parasitic infections • Neuronal tissue degeneration - plays a role in neuronal injury through activation of N-methyl-D-aspartate (NMDA) receptor
Markers of Detoxification		
Para-Hydroxyphenyllactate • Pro-oxidant • Carcinogenic metabolite of Tyrosine • Promotes lipid peroxidation in liver	• Antioxidants	• Tumor tissue • Liver disease • Scurvy • Lactic acidosis • Inefficient catabolism of tyrosine
Orotate • Sensitive marker of ammonia build-up • Pyrimidine synthesis	• Alpha-Ketoglutarate • Aspartic acid • Magnesium • Arginine • Vitamin B6 • Folate • L-Citrulline	• Folate malabsorption •Excess glutamine intake • High cell turnover (tissue breakdown, menses) • Alcohol intake • Insufficient detoxification of ammonia load through urea cycle
Pyroglutamate By- product of glutathione-dependent amino acid recovery from kidneys due to inefficient recycling of GSH	• N-acetylcysteine • Glycine • Taurine • Glutathione	• Glycine deficiency • Acetaminophen use • Glutathione depletion • Vegetarian or low-protein diet • Glutamine degradation (hyperammonemia, urea cycle defects)
Benzoate Combines with glycine to form hippurate in the liver	• Glycine	• Hyperammonemia • Toluene exposure • Bacterial metabolism of phenylalanine (gut, urinary tract) • Food additive (sodium benzoate), cranberries
Hippurate	• Glycine	As Benzoate • Uremia

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Markers of Bacterial Dysbiosis		
Para-Hydroxybenzoate	• Digestive aids • Fiber • Phytonutrients • Glycine, Vitamin B5 (Hepatic Phase I & II support) • Pre and Probiotics • Essential Fatty Acids • Glutamine and other free form amino acids to normalize gut permeability • Restore Acid/Alkaline Balance • Eliminate IgG & IgE-mediated food allergies	• Liver disease • Digestive failure • Compromised energy production and cellular metabolic pathways • Gastrointestinal pathology (celiac's, enteritis, small bowel disease, intestinal resection, intestinal obstruction, lactose intolerance)
Para-Hydroxyphenylacetate	As para-Hydroxybenzoate	As para-Hydroxybenzoate • Giardiasis • Tyrosine degradation from *Proteus vulgaris/Clostridium difficile* in gut
2-Hydroxyphenylacetate	As para-Hydroxybenzoate	As para-Hydroxybenzoate • Uremia
3-Indoleacetate	As para-Hydroxybenzoate	• As para-Hydroxybenzoate
Tricarballylate Inhibits Citrate uptake. Chelates divalent cations like Mg.	As para-Hydroxybenzoate • Magnesium • Calcium • Zinc	As para-Hydroxybenzoate • Bacterial conversion of CAC intermediate, aconitate into tricarballylate

Note: Dysbiosis may be influenced by excess use of antacids; prescription medications; NSAIDS; broad-spectrum antibiotics with consequent abnormal growth of unfavorable microflora; food allergies; and the consumption of contaminated foods.

This test does not assess for neonatal inborn errors of metabolism

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