



## Amino Acids Analysis

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### Why is this test important?

Amino acids are the building blocks that make up protein in all bodily tissues, including bone, muscles, ligaments, tendons, nails, hair, glands and organs. Amino acids are also the basic constituents of all hormones, enzymes and neurotransmitters.

Assessment of amino acid levels will help to identify contributors to illness and allow for precise replacement of deficient amino acids.

Because various vitamins and minerals are used as cofactors in amino acid metabolism, imbalances in amino acids noted on the test report can also point to insufficiencies of some of these cofactor nutrients.

Inborn dysfunctions of metabolism, such as phenylketonuria (PKU) or cystinuria, may be revealed by this profile.

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### What does this test involve?

This test can either be performed on a 24-hour urine collection or a fasting plasma specimen.

The Urine and Plasma Amino Acids Analysis reports consist of 43 and 41 individual metabolites, respectively. A Urine or Plasma "Representativeness" index provides a quick measurement of reliability of the specimen for testing.

The report includes detailed commentary on abnormal findings, a "Supplement Schedule" which lists recommended replacement amounts of the subnormal amino acids, and an "Interpretation At A Glance" which suggests the likelihood of imbalances in the various systems as well as insufficiencies of the nutrient cofactors.

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### What are the consequences of Amino Acid imbalances?

Because amino acids are involved in every bodily system, deficiencies or imbalances in these compounds can lead to disorders of behavior and mood, digestion and absorption, hormone balance, cardiovascular function, detoxication, oxidative stress, pH regulation, and the musculoskeletal system.

## Gastrointestinal

### *Suspect*

#### **Suspect incomplete digestive proteolysis or leaky gut if:**

- Elevated ANSERINE, CARNOSINE & low (or low normal) essential amino acids (dietary peptides )
- Low leucine, isoleucine, valine

#### **Suspect fat maldigestion if:**

- Low or elevated (urine only) taurine or glycine (needed for bile salt production)

#### **Suspect intestinal malabsorption if:**

- Low THREONINE and low levels of other essential amino acids

#### **Suspect intestinal dysbiosis if:**

- Elevated gamma-aminobutyric acid, alpha-aminoadipic acid, beta-alanine, ethanolamine or ammonia (may be produced by intestinal bacteria or yeast)

### *Consider*

- Rule out pancreatic dysfunction, zinc deficiency (peptidases dependent upon zinc)
- Intestinal Permeability Assessment
- Comprehensive Digestive Stool Analysis
- Supplement with appropriate amino acids

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- Rule out deficiency of fat-soluble nutrients

- Rule out rapid transit time
- Comprehensive Digestive Stool Analysis
- Food Antibody Assessment (food sensitivity may cause malabsorption)

- Comprehensive Digestive Stool Analysis

## Cardiovascular

### *Suspect*

#### **Suspect increased susceptibility to occlusive arterial disease if:**

- Elevated HOMOCYSTEINE
- Low cystathionine
- Elevated or low methionine, cysteine or taurine

### *Consider*

- Supplement with magnesium, vitamin B6, B12, folic acid, serine, or betaine as needed (to facilitate methionine metabolism)
- Comprehensive Cardiovascular Assessment to assess specific parameters of cardiovascular status

## Oxidative Stress

### *Suspect*

#### **Suspect oxidative stress if:**

- Significantly elevated cystine, compared to cysteine (urine only) (cystine is the oxidized form of cysteine)
- Low cyst(e)line (plasma or urine) (cysteine necessary for glutathione production)
- Low or elevated (urine only) taurine (taurine scavenges hypochlorite ions)

### *Consider*

- Oxidative Stress Analysis (separate or included in Comprehensive Detoxification Profile)
- Antioxidant support as needed
- Rule out magnesium deficiency

# Detoxification

## *Suspect*

### **Suspect impaired ammonia detoxification if:**

- Elevated GLUTAMINE with elevated arginine or citrulline or ornithine or argininosuccinic acid and low urea (impaired urea cycle)
- Elevated ammonia (only if low urea)
- Elevated ammonia with high urea suggests protein overload
- Elevated ammonia with high ammonia concentration and normal urea suggests decayed specimen

## *Consider*

- STAT blood venous ammonia measurement, to confirm ammonia excess
- Reduce protein intake to less than 60 grams/day
- Alpha ketoglutarate (1500-3000 mg/day)  
Consider giving 3-6 gm/day if confirmed NH<sub>3</sub> toxicity

### **Suspect impaired hepatic detoxification if:**

- Elevated or low methionine, cysteine, cystathionine, taurine (suggestive of impaired methylation, sulfation, amino acid conjugation)
- Elevated beta alanine (may lead to taurine deficiency)
- Low glycine, glutamine, aspartic acid (utilized in Phase 2 detoxication)

- Supplement with amino acids, vitamin B6, B12, folic acid or betaine as needed
- Comprehensive Detoxification Profile

# Musculoskeletal

## *Suspect*

### **Suspect increased risk of collagen or skeletal disorders if:**

- Elevated HOMOCYSTEINE with low cystathionine (impaired methionine metabolism)  
Homocysteine interferes with crosslinking of collagen
- Elevated or low cyst(e)ine, taurine
- Low methionine, lysine
- Low leucine, isoleucine, valine (branched-chain amino acids)  
May be elevated in catabolic disorders
- Elevated hydroxyproline and proline, 3-methylhistidine (suggestive of tissue catabolism)
- Elevated anserine, carnosine (incomplete digestion suggestive of poor tissue regeneration)

## *Consider*

- Supplement with magnesium, vitamin B6, B12, folic acid, betaine as needed.
- Supplement with appropriate amino acids
- Bone Resorption Assessment to assess bone status
- Ensure adequate zinc
- Comprehensive Digestive Stool Analysis

# Nutrient Adequacy

## *Suspect*

## *Consider*

### **Suspect increased need for magnesium if:**

- Elevated ethanolamine, compared with phosphoethanolamine (conversion dependent upon Mg)
- Elevated phosphoserine, compared with serine (conversion dependent upon Mg)
- Low or elevated (urine only) taurine (low taurine causes body to waste Mg)
- Elevated citrulline or aspartic acid (conversions dependent upon Mg)

### **Suspect increased need for iron if:**

Elevated phenylalanine  
(unless elevated tyrosine, tryptophan)  
(conversion dependent upon Fe)  
Low histidine  
(iron absorption dependent on HCl)

- Confirm deficiency before supplementation (e.g. ferritin, serum iron, TIBC, % saturation, transferrin)

### **Suspect increased need for manganese if:**

- Elevated arginine, compared with ornithine (arginase dependent upon Mn)
- Elevated alanine, alpha-aminoadipic acid, tyrosine, leucine, isoleucine, or valine (all are dependent upon alpha-ketoglutarate which depends upon isocitrate dehydrogenase, a Mn-dependent enzyme)
- Low histidine (hypochlorhydria from deficient histamine, may lead to Mn malabsorption)
- Low threonine (suggests general malabsorption)

- Erythrocyte or Hair Elemental Analysis  
If confirmed low Mn, rule out hyperglycemia (interference with citric acid cycle, leading to poor breakdown of carbohydrates)

### **Suspect increased need for zinc if:**

- Elevated ANSERINE, CARNOSINE (peptidases require zinc)
- Elevated phosphoethanolamine with elevated phosphoserine
- Elevated leucine, isoleucine and valine (Branched-chain amino acid peptidases require zinc)

### **Suspect increased need for molybdenum if:**

- Elevated taurine (with normal beta-alanine) (May suggest block in sulfoxidation)
- Elevated cyst(e)ine (with normal lysine and ornithine)
- (Sulfoxidation dependent upon Mo)

- Erythrocyte or Hair Elemental Analysis
- Comprehensive Detoxification Profile

### **Suspect increased need for vitamin B6 (P5-P') if:**

- Elevated CYSTATHIONINE, HOMOCYSTINE, serine, tyrosine, alpha-aminoadipic acid, beta-alanine, alanine, threonine, ornithine, glycine, aspartic acid, beta-aminoisobutyric acid, leucine, isoleucine, valine
- Low cysteine (compared with cystathionine) or low taurine (compared to cyst(e)ine)

- Mg, riboflavin, zinc (needed for B6 activation)

# Nutrient Adequacy

<i>Suspect</i>	<i>Consider</i>
<p><b>Suspect increased need for folic acid if:</b></p> <ul style="list-style-type: none"> <li>Elevated HOMOCYSTEINE, SARCOSINE, glycine, serine, 1-methylhistidine, 3-methylhistidine, methionine, cystathionine or histidine</li> </ul>	
<p><b>Suspect increased need for vitamin B12 if:</b></p> <p>Elevated homocysteine, or elevated beta amino-isobutyric acid, and glycine</p>	
<p><b>Suspect increased need for fat-soluble vitamins if:</b></p> <ul style="list-style-type: none"> <li>Low or elevated (urine only) TAURINE, low GLYCINE (needed for bile salt production)</li> <li>Elevated beta-alanine (may lead to taurine deficiency)</li> <li>Low threonine (suggests general malabsorption)</li> </ul>	

# Endocrine

<i>Suspect</i>	<i>Consider</i>
<p><b>Suspect adrenal insufficiency if:</b></p> <ul style="list-style-type: none"> <li>Low ALANINE (increased conversion of alanine to pyruvate)</li> <li>Low essential amino acids (impaired digestive enzyme activity)</li> <li>Elevated ornithine (weakness of ornithine transaminase)</li> </ul>	<ul style="list-style-type: none"> <li>Adrenocortex Stress Profile to assess cortisol and DHEA levels</li> <li>Digestive enzyme support, as needed</li> </ul>
<p><b>Suspect adrenal hyperactivity if:</b></p> <ul style="list-style-type: none"> <li>Elevated ALANINE (increased conversion from pyruvate)</li> <li>Low arginine, tryptophan, tyrosine (upregulation of arginase and oxygenase enzymes)</li> </ul>	<ul style="list-style-type: none"> <li>Adrenocortex Stress Profile to assess cortisol and DHEA levels</li> </ul>
<p><b>Suspect hyperinsulinemia if:</b></p> <ul style="list-style-type: none"> <li>Low phenylalanine (upregulated conversion to tyrosine)</li> <li>Elevated serine, alanine, glycine (gluconeogenic amino acids)</li> </ul>	<ul style="list-style-type: none"> <li>Measurement of fasting or 2-hour post-prandial insulin or Glucose/Insulin Tolerance Test</li> </ul>
<p><b>Suspect parathyroid dysfunction if:</b></p> <ul style="list-style-type: none"> <li>Elevated phosphoserine with elevated phosphoethanolamine</li> </ul>	<ul style="list-style-type: none"> <li>Evaluate parathyroid function with appropriate testing</li> </ul>

# Neurological

<i>Suspect</i>	<i>Consider</i>
<p><b>Suspect neurological / behavioral problems if:</b></p> <ul style="list-style-type: none"> <li>Elevated or low tryptophan, taurine, phenylalanine, tyrosine (neurotransmitter precursors)</li> </ul>	<ul style="list-style-type: none"> <li>Supplement with appropriate amino acids, vitamin B6</li> </ul>
<ul style="list-style-type: none"> <li>Elevated (or normal) homocysteine, with elevated or low methionine &amp; low cystathionine (suggestive of low S-adenosylmethionine, low taurine, low B6)</li> </ul>	<ul style="list-style-type: none"> <li>Supplement with appropriate amino acids, magnesium, vitamin B6</li> </ul>
<ul style="list-style-type: none"> <li>Amino acid imbalances suggestive of low vitamin B6 (see section on B6)</li> </ul>	<ul style="list-style-type: none"> <li>Supplement with vitamin B6. Ensure adequacy of zinc, riboflavin, magnesium (needed for B6 activation)</li> </ul>
<ul style="list-style-type: none"> <li>Amino acid imbalances suggestive of low vitamin B12 (see section on B12)</li> </ul>	<ul style="list-style-type: none"> <li>Supplement with appropriate amino acids, vitamin B12</li> </ul>

# Sources of some Amino Acids (in descending order of concentration)

Amino Acid	Source
<b>ARGININE</b>	<ul style="list-style-type: none"><li>poultry, meats, fish, beans (esp. soy), grains, nuts &amp; seeds, gelatin, cereals (esp. buckwheat groats, oatmeal and millet), milk, cheese and eggs, wheat germ, some vegetables (esp. green peas, asparagus, broccoli, swiss chard, corn, white potato, onion and spinach), avocado, chocolate.</li></ul>
<b>CYSTEINE</b>	<ul style="list-style-type: none"><li>meat, poultry, fish, grains, beans (esp. soy), eggs, nuts &amp; seeds, milk, cheese, cereals (esp. couscous). Also derives from methionine.</li></ul>
<b>HISTIDINE</b>	<ul style="list-style-type: none"><li>meats, poultry, fish, beans (esp. soy), cheese, milk, eggs, grains, nuts &amp; seeds, cereals, white potato.</li></ul>
<b>ISOLEUCINE</b>	<ul style="list-style-type: none"><li>poultry, meats, fish, beans (esp. soy), milk, cheese, eggs, grains, cereals (esp. millet), nuts &amp; seeds, some vegetables (esp. swiss chard, corn, green peas, white potato and spinach), avocado.</li></ul>
<b>LEUCINE</b>	<ul style="list-style-type: none"><li>poultry, fish, beans (esp. soy), milk, meats, cheese, eggs, grains, cereals (esp. millet), nuts &amp; seeds, gelatin, some vegetables (esp. sweet potato, white potato, spinach, corn, green peas, asparagus, broccoli, swiss chard, mushrooms and tomato), avocado, wheat germ.</li></ul>
<b>LYSINE</b>	<ul style="list-style-type: none"><li>poultry, meats, fish, beans (esp. soy), milk, cheese, eggs, grains, cereals (esp. oatmeal), gelatin, some vegetables (esp. white potato, green peas, asparagus, broccoli, corn, mushrooms and spinach), avocado, wheat germ, chocolate.</li></ul>
<b>METHIONINE</b>	<ul style="list-style-type: none"><li>poultry, meats, fish, grains, beans (esp. soy), nuts &amp; seeds, cereals (esp. couscous, millet and oatmeal), gelatin.</li></ul>
<b>PHENYLALANINE</b>	<ul style="list-style-type: none"><li>poultry, meats, fish, milk, cheese, eggs, beans (esp. soy), grains, cereals (esp. millet and oatmeal), nuts &amp; seeds, some vegetables, sweet potato, corn, green peas, white potato, spinach and swiss chard), gelatin, avocado, chocolate.</li></ul>
<b>THREONINE</b>	<ul style="list-style-type: none"><li>poultry, meats, fish, milk, beans (esp. soy), cheese, eggs, grains, nuts &amp; seeds, cereals, gelatin, some vegetables (corn, green peas, white potato and spinach).</li></ul>
<b>TRYPTOPHAN</b>	<ul style="list-style-type: none"><li>meats, poultry, fish, beans (esp. soy), milk, cheese, eggs, grains, cereals, nuts &amp; seeds.</li></ul>
<b>TYROSINE</b>	<ul style="list-style-type: none"><li>poultry, meats, fish, beans (esp. soy), cheese, eggs, milk, grains, cereals (esp. oatmeal and couscous), some vegetables (corn, white potato and spinach), nuts &amp; seeds. Also derives from phenylalanine.</li></ul>
<b>VALINE</b>	<ul style="list-style-type: none"><li>poultry, meats, fish, milk, cheese, eggs, beans (esp. soy), grains, nuts &amp; seeds, cereals (esp. in millet, buckwheat groats, oatmeal), some vegetables (white potato, sweet potato, broccoli, corn, green peas, spinach and swiss chard), avocado, chocolate.</li></ul>

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