Amino Acid Testing Part Two

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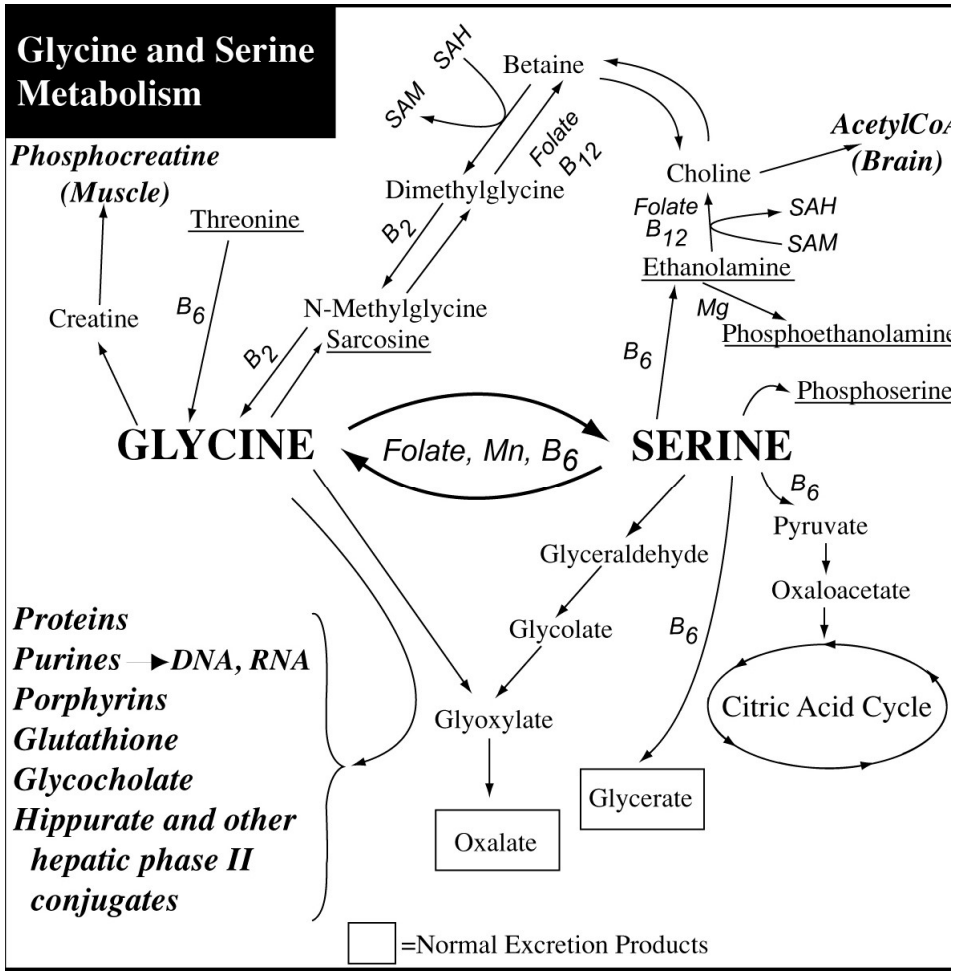
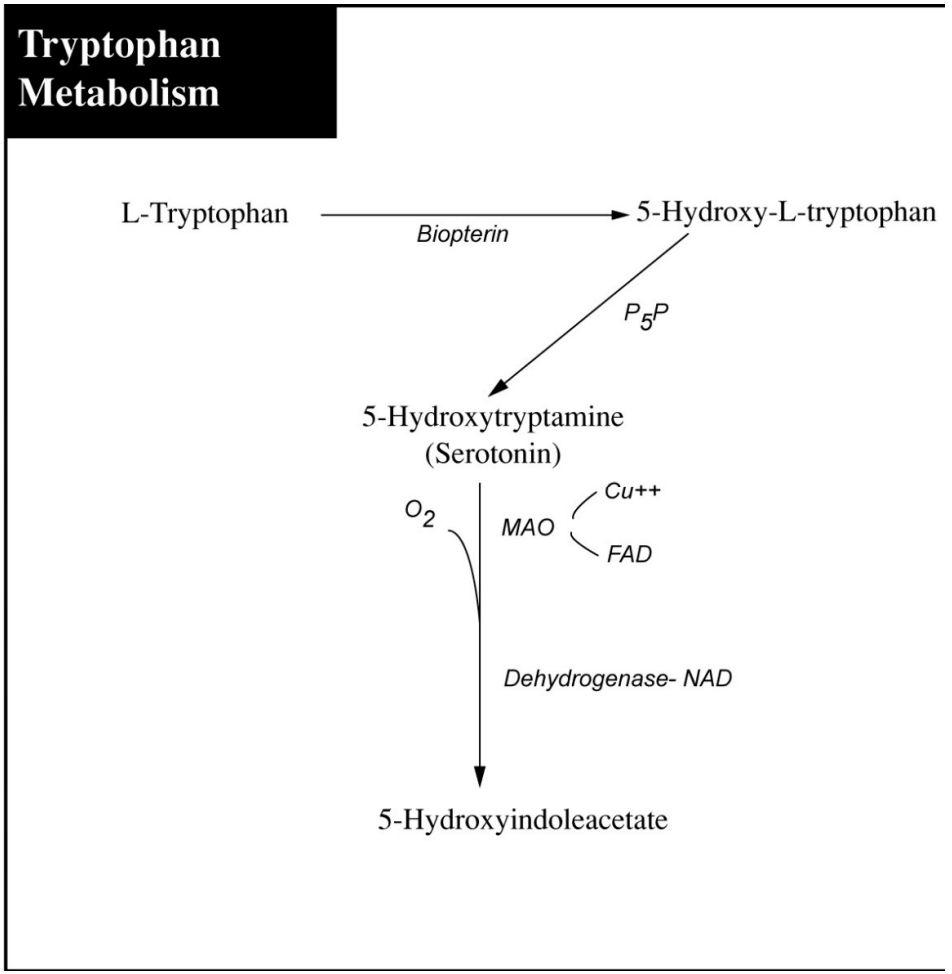
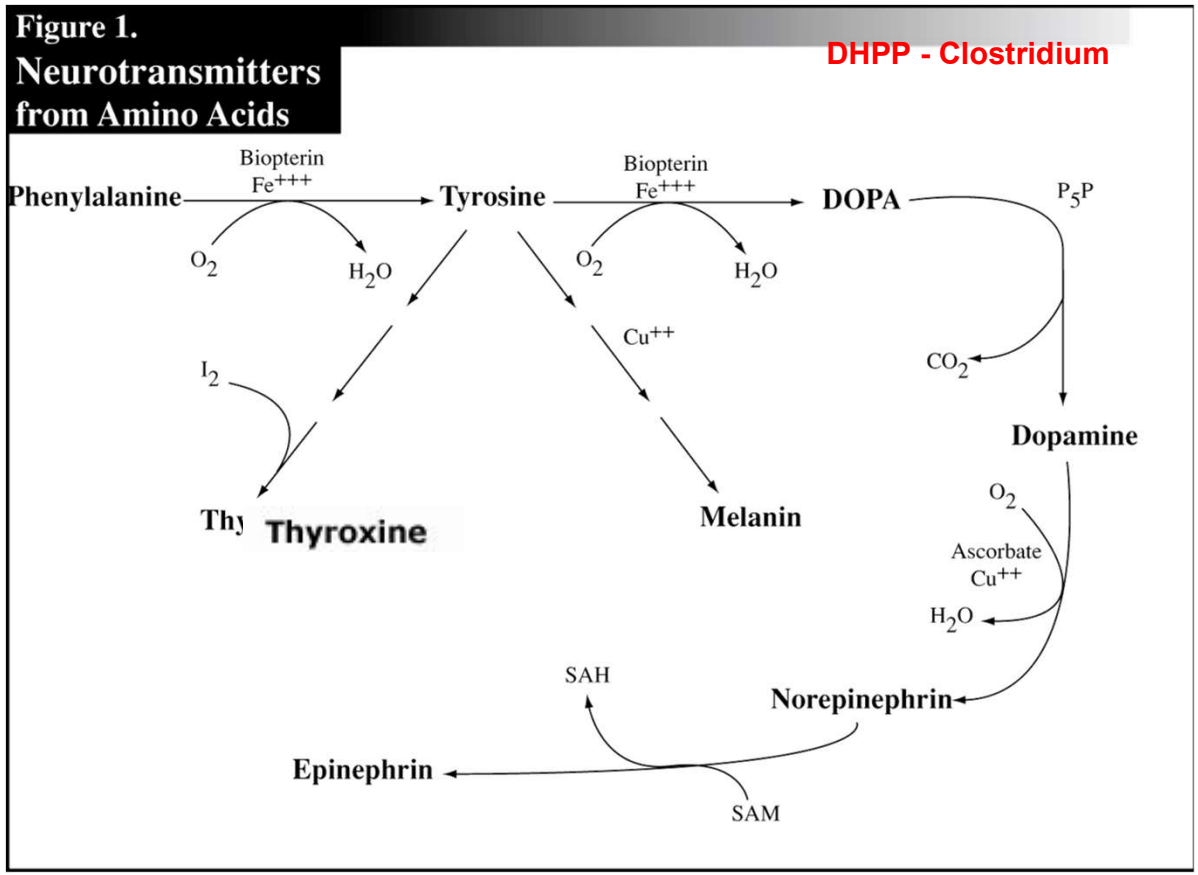
Glycine and Serine Metabolism



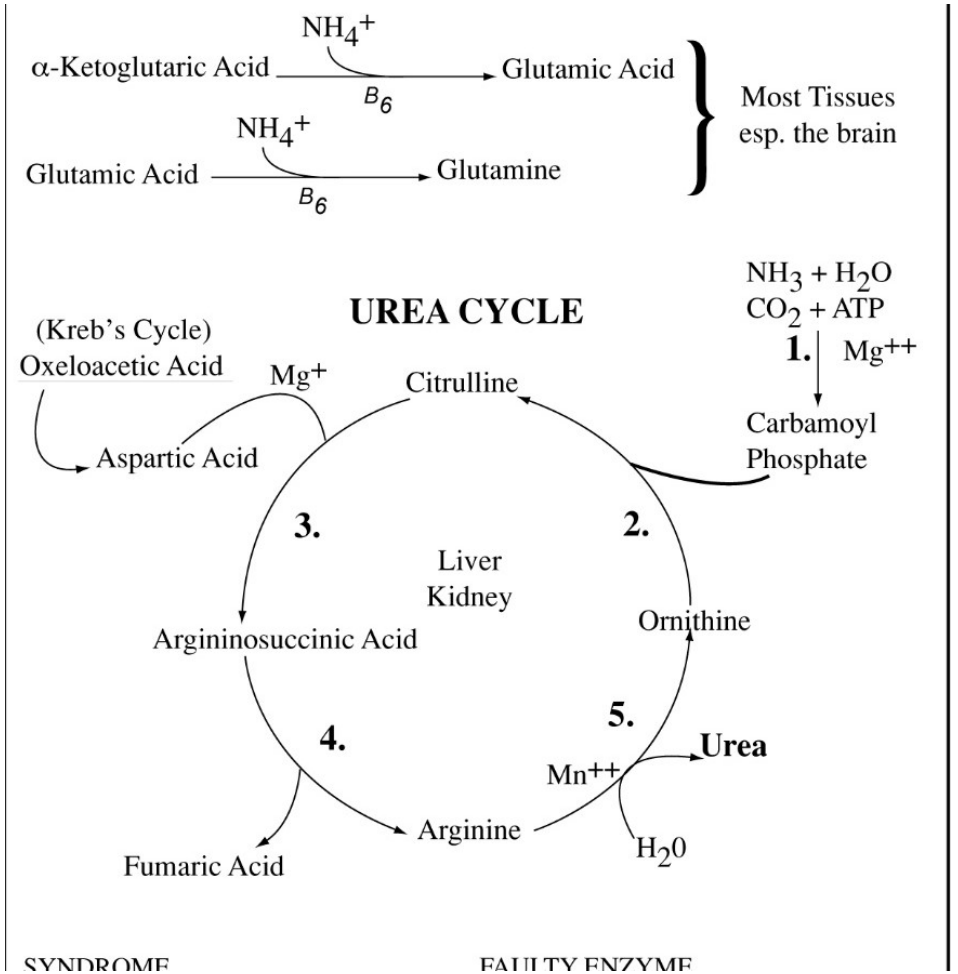
Tryptophan Metabolism



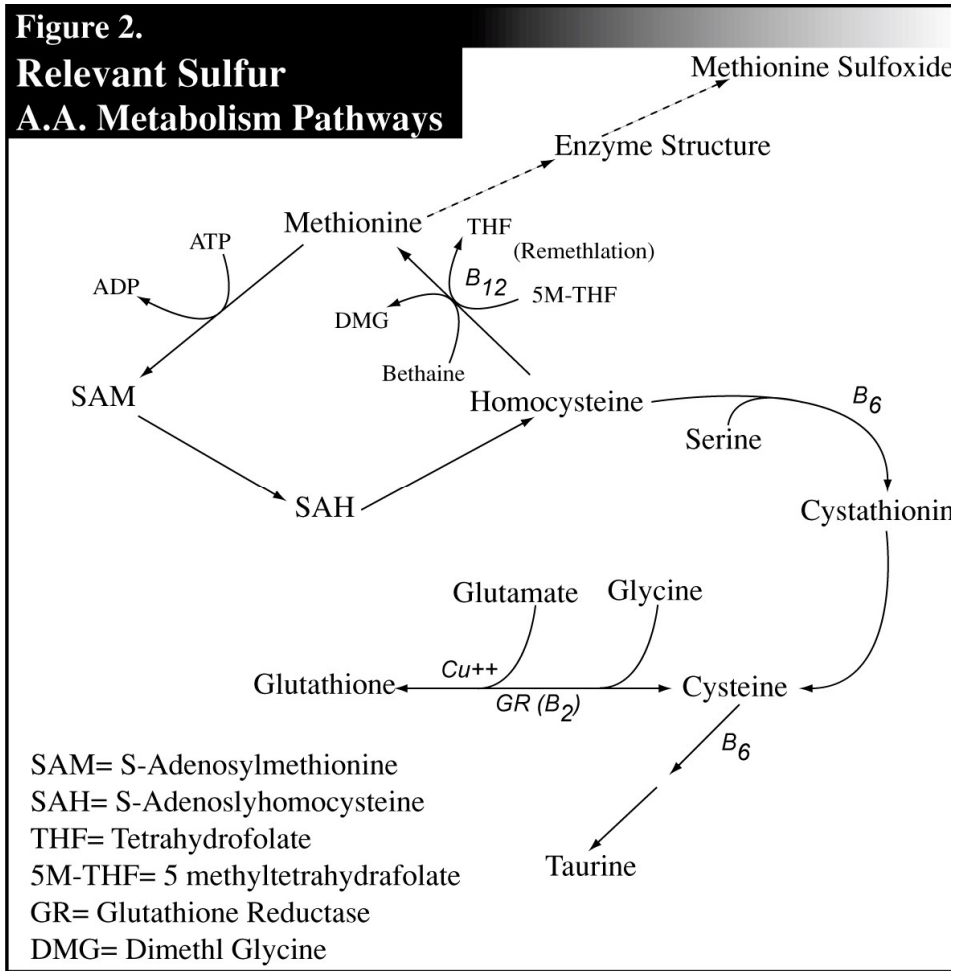
Neurotransmitters from Amino Acids



Ammonia Metabolism Pathways



Sulfur A.A. Metabolism Pathways



AA: Plasma

- Reflects the dynamics of amino acid exchange between muscle, liver, gut, brain and kidney tissues
- Determines the rate of tissue-dependent processes
- Due to the strong inherent homeostatic mechanisms, some values may appear normal while being functionally abnormal

AA: Fasting Plasma

- Low levels - metabolic hypofunction
  - malabsorption
  - insufficient intake of protein
  - insufficient cofactors
  - genetic factors
- High levels - metabolic dysfunction
  - malabsorption (esp. due to drugs)
  - imbalanced protein intake
  - insufficient cofactors
  - catabolic states

AA: Cofactor Indicators

Vitamin and Mineral Indications From Amino Acids

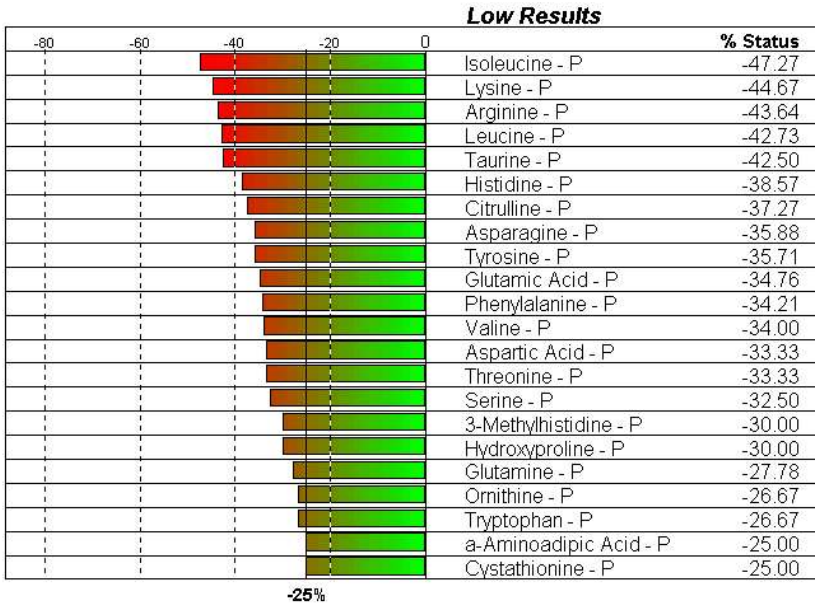
Ratio	Specimen	H/L	Nutrient
Pro:HPro	Urine	H	Vitamin C
Glu:Gln	Plasma	H	B6 (P5P)
Sarc/Gly	Plasma	H	B12, Folate
His	Plasma	L	Folate
Lys	Plasma	L	Carnitine

AA: Reference Ranges

- Based on nitrogen balance studies
- Predicted on the smallest amounts compatible with normal size growth in infants and children
- Published estimates show a wide range of variable needs, even within a single study
- Subtle effects on neurological and psychological function rarely even considered in published studies

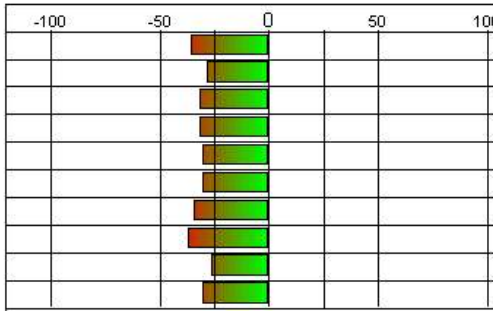
AA: Reference Ranges

- This is a pattern of an overall deficiency syndrome that would show no values out of reference range



	% Status
Isoleucine - P	-47.27
Lysine - P	-44.67
Arginine - P	-43.64
Leucine - P	-42.73
Taurine - P	-42.50
Histidine - P	-38.57
Citrulline - P	-37.27
Asparagine - P	-35.88
Tyrosine - P	-35.71
Glutamic Acid - P	-34.76
Phenylalanine - P	-34.21
Valine - P	-34.00
Aspartic Acid - P	-33.33
Threonine - P	-33.33
Serine - P	-32.50
3-Methylhistidine - P	-30.00
Hydroxyproline - P	-30.00
Glutamine - P	-27.78
Ornithine - P	-26.67
Tryptophan - P	-26.67
a-Aminoadipic Acid - P	-25.00
Cystathionine - P	-25.00

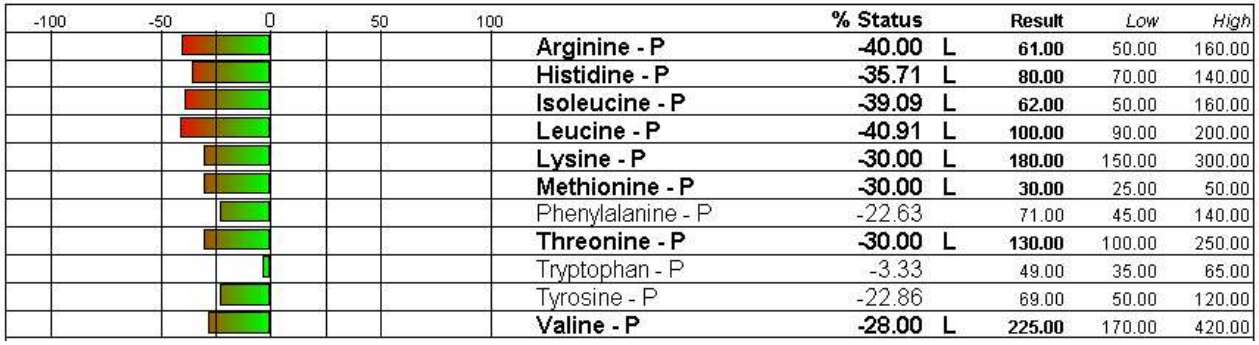
AA: Reference Ranges



	% Status		Result	Low	High
Arginine - P	-35.45	L	66.00	50.00	160.00
Histidine - P	-28.57	L	85.00	70.00	140.00
Isoleucine - P	-31.82	L	70.00	50.00	160.00
Leucine - P	-31.82	L	110.00	90.00	200.00
Lysine - P	-30.00	L	180.00	150.00	300.00
Methionine - P	-30.00	L	30.00	25.00	50.00
Phenylalanine - P	-34.21	L	60.00	45.00	140.00
Threonine - P	-37.33	L	119.00	100.00	250.00
Tryptophan - P	-26.67	L	42.00	35.00	65.00
Valine - P	-30.00	L	220.00	170.00	420.00

- This is a pattern of
  - poor quality diet
  - inadequate digestion/assimilation
  - reduced skeletal muscle activity

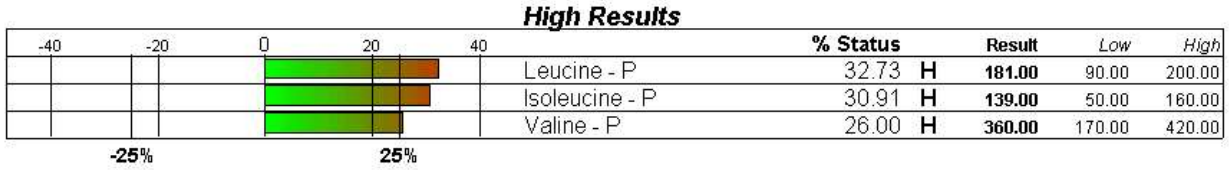
AA: Reference Ranges



	% Status		Result	Low	High
Arginine - P	**-40.00**	**L**	**61.00**	50.00	160.00
Histidine - P	**-35.71**	**L**	**80.00**	70.00	140.00
Isoleucine - P	**-39.09**	**L**	**62.00**	50.00	160.00
Leucine - P	**-40.91**	**L**	**100.00**	90.00	200.00
Lysine - P	**-30.00**	**L**	**180.00**	150.00	300.00
Methionine - P	**-30.00**	**L**	**30.00**	25.00	50.00
Phenylalanine - P	-22.63		71.00	45.00	140.00
Threonine - P	**-30.00**	**L**	**130.00**	100.00	250.00
Tryptophan - P	-3.33		49.00	35.00	65.00
Tyrosine - P	-22.86		69.00	50.00	120.00
Valine - P	**-28.00**	**L**	**225.00**	170.00	420.00

- This is a pattern of
  - Pancreatic enzyme deficiency
  - Zinc deficiency

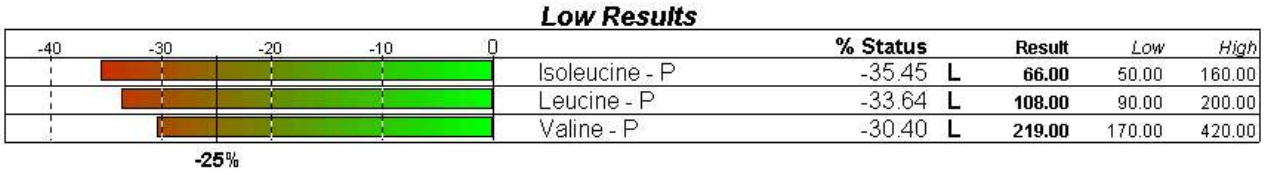
AA: Reference Ranges



	% Status		Result	Low	High
Leucine - P	32.73	H	**181.00**	90.00	200.00
Isoleucine - P	30.91	H	**139.00**	50.00	160.00
Valine - P	26.00	H	**360.00**	170.00	420.00

- This is a pattern of deficiency of
  - B6, B5 and
  - Zinc

AA: Reference Ranges



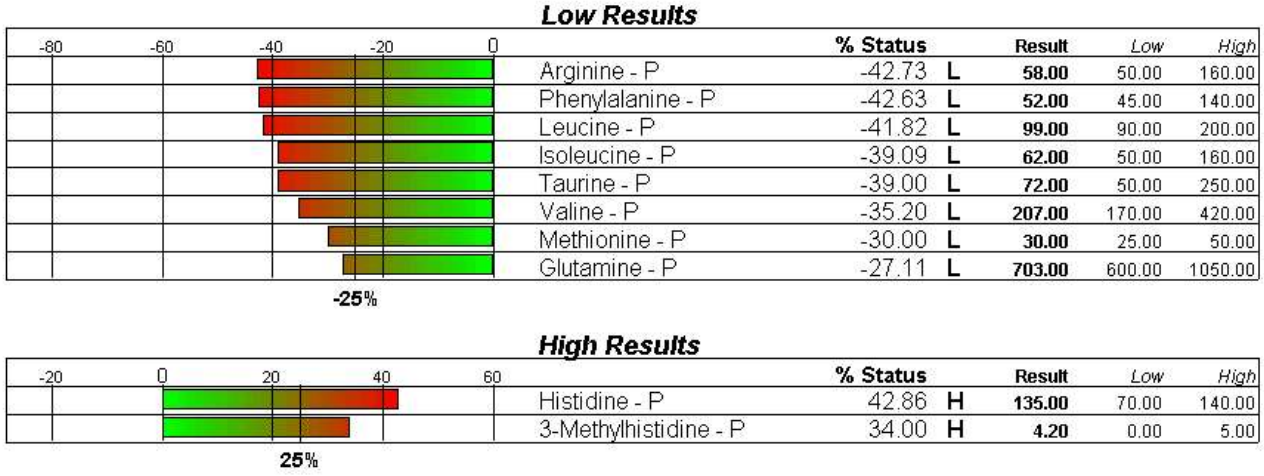
Low Results

-40 -30 -20 -10 0		% Status		Result	*Low*	*High*
	Isoleucine - P	-35.45	L	**66.00**	50.00	160.00
	Leucine - P	-33.64	L	**108.00**	90.00	200.00
	Valine - P	-30.40	L	**219.00**	170.00	420.00

-25%

- This is a pattern of chronic depletion of
  - B6, B5 and Zinc
  - Branched Chain Amino Acids (BCAA)
  - resulting in loss of muscle mass, reduced liver synthesis and sometimes resulting in alopecia or sleep apnea

AA: Reference Ranges



Low Results

	% Status		Result	*Low*	*High*
Arginine - P	-42.73	L	**58.00**	50.00	160.00
Phenylalanine - P	-42.63	L	**52.00**	45.00	140.00
Leucine - P	-41.82	L	**99.00**	90.00	200.00
Isoleucine - P	-39.09	L	**62.00**	50.00	160.00
Taurine - P	-39.00	L	**72.00**	50.00	250.00
Valine - P	-35.20	L	**207.00**	170.00	420.00
Methionine - P	-30.00	L	**30.00**	25.00	50.00
Glutamine - P	-27.11	L	**703.00**	600.00	1050.00

-80 -60 -40 -20 0

-25%

High Results

	% Status		Result	*Low*	*High*
Histidine - P	42.86	H	**135.00**	70.00	140.00
3-Methylhistidine - P	34.00	H	**4.20**	0.00	5.00

-20 0 20 40 60

25%

- Muscle catabolism

AA: BCAA

- Not used for neurotransmitter or bile acid formation
- Regulators of neurotransmitter metabolism thru competition for binding sites in the brain
- Stored in muscle, where converted to glutamine and alanine by liver and kidney
- Use in stress induced muscle protein synthesis loss (diabetic, injury, emotional trauma, etc.)

AA: BCAA

- ↑ BCAAs suggest inadequate B6, B5 (Pantothenic acid spares sulfur aminos). Supplementation will produce coenzyme A and zinc.
- ↓ BCAAs suggests chronic depletion
- BCAAs increase respiration and decrease sleep apnea

Kirvela O, Thorpy M, Takala J, Askanazi J, Singer P, Kvetan V. Respiratory and sleep patterns during nocturnal infusions of branched chain amino acids. Acta Anesthesiol Scand, 1990; 34: 645-8.

AA: BCAA

- BCAAs ⇨ Alanine
- ↓ Alanine suggests B6 deficiency
- Alanine carries nitrogen from muscle to liver where it is converted to glucose
- Alanine Transferase (ALT), the enzyme in this reaction, is B6 dependant
- ↓ Alanine = Hypoglycemia

AA: BCAA

Supplementation will

- increase respiration
- decrease sleep apnea
- stimulate food intake in loss of appetite
- slow transit time (in diarrhea)
- leucine inhibits liver protein degradation

AA: Sarcosine

- N-methylglycine, aka Sarcosine, is formed by methyl group transfer from methionine to glycine on the pathway to choline
- Cofactors are B12 and folate on pathway to choline
- ↑ in B2 deficiency on the return pathway to glycine
- ↑ in Parkinson's Disease

AA: Hydroxyproline

- Synthesized from proline
- ↑ Urine levels are consistent with high bone turnover
- ↑ Or normal urine proline and ↓ h-proline indicate vitamin C and iron deficiency
- Also correlates with serum alkaline phosphatase, thus also a functional zinc sufficiency indicator
- ↑ Free plasma h-proline found in multiple myeloma

AA: α-Aminoadipic Acid

- Specific marker for B6 (and αKG) [Homocysteine is B12 specific]
- Cardiovascular Disease risk marker*
- Seen in impaired lysine metabolism
- May be connected with neurological disorders (Reynaud's, petit mal seizures, low BP and susceptibility to herpes outbreaks)
- ↑ α-Aminoadipic Acid can result from excess lysine supplementation

***Olszewski AJ, Szostak WB. Homocysteine content of plasma protein in ischemic heart disease [published erratum appears in Atherosclerosis 1991, May; 88(1): 97-8.] Atherosclerosis, 1988; 69: 109-13.**

Amino Acids: β-Amino Acids

Most abundant:

- Taurine
- β-alanine
- γ-aminobutyrate (GABA)
- β-alanylhistidine (Carnosine)
- β-alanyl-1-methylhistidine (Anserine)

Clinical Tips

- ↓ Taurine suggests excess oxidative damage
- Chronic deficiency results in extreme sensitivity to environmental allergens (“universal reactor”)
- A key component of bile, ↓ Taurine can result in problems with fat digestion, ↓ Fat soluble vitamins, and ↑ Cholesterol.

Clinical Tips

- ↓ Taurine contributes to a host of cardiovascular and neurological problems.
- ↓ Taurine increases platelet aggregation.
- Beta-agonist drugs reduce stores of taurine.
- ↑ Ornithine indicates excess ammonia buildup (Gut bacteria are a major source of ammonia)
- ↑ Ornithine (any ↑ ammonia) may indicate food intolerance (esp. with ↓BUN)

Clinical Tips

- ↓ Glutamine suggests ammonia buildup, even more likely when ↑ Glutamic acid
- Glutamine levels may fall following amino supplementation if aminos are effective in healing GI tissues

Clinical Tips

- ↑ Serine:Glycine ratio occurs in depressed individuals

Altamura C, Maes M, Dai J, Meltzer HY. *Plasma concentrations of excitatory amino acids, serine, glycine, taurine and histidine in major depression.* Eur Neurophsychopharmacolo 1995; 5 Suppl: 71-5.

Clinical Tips

- ↓Serine and ↑Homocysteine can be normalized with betaine (DMG)

Dudman NP, Tyrell PA, Wilcken DE. *Homocysteinemia: depressed plasma serine levels.* Metabolism, 1987; 36: 198-201.

Clinical Tips

- Excess methionine can chelate copper[1], cobalt[1] and lead[2].

[1]Domingo JL, Llobet JM. *Treatment of acute cobalt intoxication in rats with l-methionine.* Rev Esp Fisiol, 1984; 40: 443-8.

[2]Kachru DN, Khandelwal S, Tandon SK. *Influence of mehtionine supplementation in chelation of lead in rats.* Biomed Environ Sci, 1989; 2:265-70.