

The 20 Amino Acids

Submitted by Natural Solutio... on Thu, 2002-05-23 13:04
in

- [Amino Acids \(references\)](#)

What They Are and How They Keep You Alive and Vibrant

Compiled by Dr. Dennis Gersten, M.D

DennisGerstenMD.com

[Alanine](#), [Arginine](#), [Aspartic Acid](#), [Asparagine](#), [Cysteine-Cystine](#), [Glutamic Acid](#),
[Glutamine](#), [Glycine](#), [Histidine](#), [Isoleucine](#), [Leucine](#), [Lysine](#), [Methionine](#),
[Phenylalanine](#), [Proline](#), [Serine](#), [Threonine](#), [Tryptophan](#), [Tyrosine](#), [Valine](#),
[GABA](#), [Taurine](#),

The 20 major amino acids, plus hundreds of minor amino acids keep us alive, vibrant, and healthy. A deficiency in a single amino acid will cause problems for us, and even a single deficiency should be replaced.

In addition to making up all protein, amino acids have numerous functions... far too many to discuss within these pages.

Before each amino acid is discussed, you will read how it is classified within the various categories, such as essential versus non-essential, glycogenic versus ketogenic, etcetera.

ALANINE Non-Essential - Proteogenic - Glycogenic
Non-Polar, Hydrophobic - Aliphatic

Main Functions:

Important source of energy for muscle.
The primary amino acid in sugar metabolism.
Boosts immune system by producing antibodies
Major part of connective tissue

Alanine Deficiencies Seen In:

hypoglycemia
muscle breakdown
fatigue
viral infections
elevated insulin and glucagon levels

Alanine Excess Seen In:

low insulin and glucagon levels
diabetes mellitus
kwashiorkor (starvation)

ARGININE

Conditionally-Essential - Proteogenic - Glycogenic - Basic Side Chains

Main Functions:

Essential for normal immune system activity.

Necessary for wound healing.
Assists with regeneration of damaged liver.
Necessary for production and release of growth hormone
Increases release of insulin and glucagon. Arginine is the most potent amino acid in releasing insulin.
Assists in healing through collagen synthesis
Precursor to GABA, an important inhibitory neurotransmitter
Aids in wound healing
Decreases size of tumors.
Necessary for spermatogenesis.

Arginine Deficiencies Seen In:

AIDS

Immune deficiency syndromes, including CFS and Gulf War Syndrome
Candidiasis

Caution:

Because of arginine's powerful boost to the immune system, people suffering from a great variety of ailments may be tempted to experiment with it. Before doing so, make sure you do not have an acute or chronic virus, such as Epstein-Barr Virus (EBV), Cytomegalovirus (CMV) or Human Herpes Virus VI (HHV6), Herpes Simplex I or II. Arginine will speed up the rate of viral growth, which can prove to be dangerous. The amino acid, Lysine, has the opposite effect on viruses, slowing down their growth.

ASPARTIC ACID

Non-Essential - Proteogenic - Glycogenic - Acid Side Chain

Main Functions:

Aspartic Acid is interconvertible with Asparagine, and therefore the two amino acids have many functions in common.

Increases stamina.

One of the two main excitatory amino acids, the other being Glutamate (Glutamic Acid).

Helps protect the liver by aiding the removal of ammonia.

Involved in DNA and RNA metabolism.

Involved in immune system function by enhancing immunoglobulin production and anti-body formation.

Aspartic Acid Deficiency Seen In:

Calcium and magnesium deficiencies. Because of this association, low aspartic acid levels should lead the clinician to test for calcium and/or magnesium deficiencies.

Aspartic Acid Excess Seen In:

Amyotrophic Lateral Sclerosis (ALS or Lou Gehrig's Disease)

Epilepsy, especially right after a seizure.

Stroke.

ASPARAGINE

Non-Essential - Proteogenic - Un-charged, Hydrophilic - Amidic

Main Functions:

Asparagine is made from Aspartic Acid plus ATP (adenosine tri-phosphate).

One of the two main excitatory neurotransmitters. Glutamate, made from glutamic acid, is the other.

Among their functions as neurotransmitters, of particular interest is the fact that Aspartic Acid and Asparagine have high concentrations in the hippocampus and the hypothalamus. The hippocampus

is a part of the brain that plays the main role in short-term memory, while the hypothalamus is involved in the biology of emotion, and serves as a neurological gate between the brain and the rest of the nervous system.

Aids in removing ammonia from the body.

May increase endurance and decrease fatigue.

Detoxifies harmful chemicals.

Involved in DNA synthesis.

Probably stimulates thymus gland.

CYSTEINE-CYSTINE

Non-Essential - Glycogenic and Ketogenic

Un-charged, Hydrophilic - Sulfur-Containing

Main Functions:

Cysteine and Cystine are interconvertible. Two molecules of Cysteine make Cystine.

Antioxidant.

Protective against radiation, pollution, ultra-violet light and other causes of increased free radical production.

Natural detoxifier.

Essential in growth, maintenance, and repair of skin.

Key ingredient in hair.

One of the 3 main sulfur-containing amino acids, along with Taurine and Methionine.

Major constituent of Glutathione, an important tripeptide made up of Cystine, Glutamic Acid, and Glycine.

Precursor to the amino acid Taurine.

Precursor to Chondroitin Sulfate, the main component of cartilage.

Cysteine/Cystine Deficiency Seen In:

Chemical Sensitivity

Food Allergy

GLUTAMIC ACID

Non-Essential - Proteogenic - Glycogenic - Acid Side Chain

Main Functions:

Glutamic Acid is a precursor to Glutamine and GABA (2 neurotransmitters).

One of two excitatory neurotransmitters, the other being aspartic acid/asparagine.

Excesses in brain tissue can call cell damage. This is thought to be one of the mechanisms by which strokes kill brain cells; that is through the release of large amounts of Glutamic Acid.

Helps stop alcohol and sugar cravings.

Increases energy.

Accelerates wound healing and ulcer healing.

Detoxifies ammonia in the brain by forming glutamine, which can cross the blood-brain barrier, which Glutamic Acid cannot do.

Plays major role in DNA synthesis.

GLUTAMINE

Non-Essential - Proteogenic - Glycogenic

Un-charged, Hydrophilic - Amidic

Main Functions:

Precursor to the neurotransmitter GABA. This is a vital function, as GABA is an inhibitory neurotransmitter that produces serenity and relaxation.

Important glycogenic amino acid, meaning that it is essential for helping to maintain normal and steady blood sugar levels.

Involved with muscle strength and endurance.

Essential to gastrointestinal function; provides energy to the small intestines. The intestines are the only organ in the body that uses Glutamine as its primary source of energy.
Glutamine has the highest blood concentration of all the amino acids.
Precursor to the neurotransmitter amino acid Glutamate (Glutamic Acid).
Involved in DNA synthesis.

Glutamine Deficiency Seen In:

Chronic Fatigue Syndrome
Alcoholism
Anxiety and Panic Disorders

Glutamine Excess Seen In:

Use of some anti-convulsant medications.

GLYCINE

Non-Essential - Proteogenic - Glycogenic
Non-Polar, Hydrophobic - Aliphatic

Main Functions:

Part of the structure of hemoglobin.
One of the two main inhibitory neurotransmitters, the other being GABA.
Part of cytochromes, which are enzymes involved in energy production.
Inhibits sugar cravings.
One of the 3 critical glycogenic amino acids, along with serine and alanine.
Involved in glucagon production, which assists in glycogen metabolism.

Glycine Deficiency Seen In:

Chronic Fatigue Syndrome
Hypoglycemia
Anemia
Viral Infections
Candidiasis

Glycine Excess Seen In:

Starvation

HISTIDINE

Essential - Proteogenic - Glycogenic - Basic Side Chains

Main Functions:

Found in high concentrations in hemoglobin.
Useful in treating anemia due to relationship to hemoglobin.
Has been used to treat rheumatoid arthritis.
Precursor to histamine.
Associated with allergic response and has been used to treat allergy.
Assists in maintaining proper blood pH.

Histidine Deficiency Seen In:

Rheumatoid arthritis
Anemia
Dysbiosis (Imbalance of intestinal bacterial flora).

Histidine Excess In:

Pregnancy

Special Functions and Predictive Value:

High Histidine levels are associated with low zinc levels. Low Histidine levels are associated with high zinc levels. Thus, abnormal Histidine levels are an indicator that zinc levels should be tested.

ISOLEUCINE

Essential - Proteogenic - Glycogenic and Ketogenic
Non-Polar, Hydrophobic - Aliphatic

Main Functions:

One of the 3 major Branched-Chain Amino Acids (BCAA), all of which are involved with muscle strength, endurance, and muscle stamina.

Muscle tissue uses Isoleucine as an energy source.

Required in the formation of hemoglobin.

BCAA levels are significantly decreased by insulin. Translation: High dietary sugar or glucose intake causes release of insulin, which, in turn, causes a drop in BCAA levels. Therefore, right before exercise, it is not wise to ingest foods high in glucose or other sugars, as the BCAA's, including Isoleucine will not be readily available to muscles.

Isoleucine Deficiency Seen In:

Obesity

Hyperinsulinemia

Panic Disorder

Chronic Fatigue Syndrome (Note: Deficiencies in BCAA in CFS, GWS, FM are associated with muscle weakness, fatigue, and post-exertional exhaustion).

Acute hunger

Kwashiorkor (starvation)

Isoleucine Excess Seen In:

Diabetes Mellitus with ketotic hypoglycemia

LEUCINE

Essential - Proteogenic - Ketogenic - Non-Polar, Hydrophobic - Aliphatic

Main Functions:

As one of the 3 branched-chain amino acids (the other 2 being Isoleucine and Valine), Leucine has all of the properties discussed with Isoleucine, as it pertains specifically to the branched-chain amino acid functions.

Potent stimulator of insulin.

Helps with bone healing.

Helps promote skin healing.

Modulates release of Enkephalins, which are natural pain-reducers.

Leucine Deficiency Seen In:

Hyperinsulinemia

Depression

Chronic Fatigue Syndrome (Note: Deficiencies in BCAA in CFS, GWS, FM are associated with muscle weakness, fatigue, and post-exertional exhaustion).

Acute hunger

Kwashiorkor (starvation)

Vitamin B-12 deficiency in pernicious anemia

Leucine Excess Seen In:

Ketosis

LYSINE

Essential - Proteogenic - Glycogenic and Ketogenic - Basic Side Chains

Main Functions:

Inhibits viral growth and, as a result, is used in the treatment of Herpes Simplex, as well as the viruses associated with Chronic Fatigue Syndrome, such as: Epstein-Barr Virus, CytoMegalovirus, and HHV6.

L-Carnitine is formed from Lysine and Vitamin C.

Helps form collagen, the connective tissue present in bones, ligaments, tendons, and joints.

Assists in the absorption of calcium.

Essential for children, as it is critical for bone formation.

Involved in hormone production.

Lowers serum triglyceride levels.

Lysine Deficiency Seen In:

Herpes

Epstein-Barr Virus

Chronic Fatigue Syndrome

AIDS

Anemia

Hair loss

Weight loss

Irritability

Lysine Excess Seen In:

Excess of ammonia in the blood

METHIONINE

Essential - Proteogenic - Glycogenic

Non-Polar, Hydrophobic - Sulfur-Containing

Main Functions:

Assists in breakdown of fats.

Precursor of the amino acids Cysteine (and Cystine) and Taurine.

Helps reduce blood cholesterol levels.

Antioxidant.

Assists in the removal of toxic wastes from the liver.

One of the sulfur-containing aminos (the others being Cysteine and the minor amino acid, Taurine).

The sulfur-containing amino acids act as anti-oxidants which neutralize free radicals.

Helps prevent disorder of hair, skin, and nails due to sulfur and anti-oxidant activity.

Precursor to Carnitine, Melatonin (the natural sleep aid) and Choline (part of the neurotransmitter,

Acetylcholine).

Involved in the breakdown of Epinephrine, Histamine, and Nicotinic Acid.

Required for synthesis of RNA and DNA.

Natural chelating agent for heavy metals, such as lead and mercury.

Methionine Deficiency Seen In:

Chemical Exposure

Multiple Chemical Sensitivity (MCS)

Vegan Vegetarians

Methionine Excess Seen In:

Severe liver disease

PHENYLALANINE

Essential - Proteogenic - Glycogenic and Ketogenic

Non-Polar, Hydrophobic - Aromatic

Main Functions:

Precursor to Tyrosine, which, in turn, is the precursor to the neurotransmitters: Dopamine and the excitatory neurotransmitters Norepinephrine and Epinephrine.

Precursor to the hormone, Thyroxine.

Enhances mood, clarity of thought, concentration, and memory.

Suppresses appetite.

Major part of collagen formation.

While the L-form of all of the other amino acids is the one that is beneficial to people, the

D and DL forms of Phenylalanine have been useful in treating pain.

DL-Phenylalanine is useful in reducing arthritic pain.

Powerful anti-depressant.

Used in the treatment of Parkinson's Disease.

Phenylalanine Deficiency Seen In:

Depression

Obesity

Cancer

AIDS

Parkinson's Disease

Caution: Phenylalanine should be avoided in:

High blood pressure. Has hypertensive properties and should be avoided with people with high blood pressure.

Pregnancy

Pigmented melanoma

PKU (phenylketonuria)

Panic disorder/anxiety attacks

Note:

See [Tyrosine](#). It is more powerful and safer in raising the level of norepinephrine, and thereby treating depression.

PROLINE

Non-Essential - Proteogenic - Glycogenic

Non-Polar, Hydrophobic - Aliphatic

Main Functions:

Critical component of cartilage, and hence health of joints, tendons and ligaments.

Involved in keeping heart muscle strong.

The main precursor to Proline is Glutamate.

Secondary precursor to Proline is Ornithine (minor amino acid).

Works in conjunction with Vitamin C in keeping skin and joints healthy.

Proline Excess Seen In:

Chronic Liver Disease

Sepsis (infection of the blood).

Acute alcohol intake.

SERINE

Non-Essential - Proteogenic - Glycogenic

Un-charged, Hydrophilic - Hydroxylic

Main Functions:

One of the 3 most important glycoenic amino acids, the others being alanine and glycine.

Critical in maintaining blood sugar levels.

Boosts immune system by assisting in production of antibodies and immunoglobulins.

Myelin sheath (the fatty acid complex that surrounds the axons of nerves is derived from serine.

One variation of Serine namely Phosphotidyl Serine, a minor amino acid serves several important functions within the central nervous system, including development of the myelin sheath. Multiple Sclerosis is one of the so-called "De-myelinating Diseases."

Required for growth and maintenance of muscle.

The amino acid Glycine is a precursor to Serine and the two are interconvertible.

Serine Deficiency Seen In:

Total body gamma and neutron irradiation

Hypoglycemia

Candidiasis

Serine Excess Seen In:

Vitamin B-6 Deficiency

Note:

Phosphoserine, a minor amino acid, a modification of Serine, is a good predictor of Vitamin B-6 deficiency, in particular the form of Vitamin B-6 called Pyridoxal-5-Phosphate (P5P). If plasma Phosphoserine levels are abnormally high, that is a clear indication of P5P deficiency. P5P is critical in amino acid processes. Tyrosine, for example, cannot be converted into the neurotransmitter Norepinephrine if there is not enough P5P. Likewise, Tryptophan cannot be converted into the neurotransmitter Serotonin if there is not enough P5P.

THREONINE

Essential - Proteogenic - Glycoenic

Un-charged, Hydrophilic - Hydroxylic

Main Functions:

Required for formation of collagen.

Helps prevent fatty deposits in the liver.

Aids in production of antibodies.

Can be converted to Glycine (a neurotransmitter) in the central nervous system.

Acts as detoxifier.

Needed by the GI (gastrointestinal) tract for normal functioning.

Provides symptomatic relief in ALS (Amyotrophic Lateral Sclerosis, Lou Gehrig's Disease).

In laboratory experiments with animals, Threonine increases thymus weight.

Threonine is often low in depressed patients. In that group of patients, Threonine is helpful in treating the depression.

Threonine Deficiency Seen In:

Depression

AIDS

Muscle Spasticity

ALS (Amyotrophic Lateral Sclerosis)

Vegetarianism

Epilepsy

Threonine Excess Seen In:

Alcohol ingestion

Those treated with sedative anti-convulsant medication (animal studies)

Vitamin B6 deficiency

Pregnancy

Liver cirrhosis

TRYPTOPHAN

Essential - Proteogenic - Glycogenic and Ketogenic

Non-Polar, Hydrophobic - Aromatic

Main Functions:

Precursor to the key neurotransmitter, serotonin, which exerts a calming effect.

Effective sleep aid, due to conversion to serotonin.

Reduces anxiety.

Effective in some forms of depression.

Treatment for migraine headaches.

Stimulates growth hormone.

Along with Lysine, Carnitine, and Taurine is effective in lowering cholesterol levels.

Can be converted into niacin (Vitamin B3).

Lowers risk of arterial spasms.

The only plasma amino acid that is bound to protein.

Tryptophan must compete with 5 other amino acids to pass through the blood-brain barrier and enter the brain. Those 5 are: tyrosine, phenylalanine, leucine, isoleucine, and valine and are called Large Neutral Amino Acids (LNAA).

Requires pyridoxal-5-phosphate (P5P) a form of vitamin B6 to be converted into serotonin. P5P deficiency will lower serotonin levels, even if Tryptophan levels are normal.

Tryptophan Deficiency Seen In:

Depression

Insomnia

Chronic Fatigue Syndrome

ALS

FDA ban of Tryptophan

Tryptophan Excess Seen In:

Increased intake of salicylates (aspirin).

Increased blood levels of free fatty acids.

Sleep deprivation.

Niacin intake.

Caution:

Simultaneous treatment with Tryptophan and Prozac (and other SSRI anti-depressants, such as Paxil and Zoloft) can produce an irreversible brain disorder called Serotonin Syndrome. This treatment combination is to be avoided.

Note:

Standard AMA, APA (American Psychiatric Association), FDA, and pharmaceutical industry position has been that Tryptophan is not an effective treatment of serotonin-depletion depressions, when compared to Prozac and other SSRI's.

Clinical experience has shown that some people respond well to Prozac while others respond well to Tryptophan in treating serotonin-depleted depressions. When the FDA banned Tryptophan, thousands of people who only had a positive response to Tryptophan (and not to Prozac) decompensated psychologically and never recovered.

Tryptophan is again available, but only through prescription and compounding pharmacies.

TYROSINE

Conditionally Essential - Proteogenic - Glycogenic and Ketogenic

Un-charged, Hydrophilic - Aromatic

Main Functions:

Precursor to neurotransmitters dopamine, norepinephrine, epinephrine (adrenaline) and melanin.

Effective anti-depressant for norepinephrine-deficient depressions. Tyrosine is preferred over Phenylalanine, which is also a precursor to all of the above neurotransmitters. Phenylalanine is one step removed from the metabolic process, and can aggravate high blood pressure.

Precursor to thyroxine and growth hormone.

Increases energy, improves mental clarity and concentration.

Requires pyridoxal-5-phosphate (P5P) a form of vitamin B6 to be converted into norepinephrine.

P5P deficiency will lower norepinephrine levels, even if Tyrosine levels are normal.

Tyrosine Deficiency Seen In:

Depression

Chronic Fatigue Syndrome

Gulf War Syndrome

Hypothyroidism

Parkinson's Disease

Drug addiction and dependency

Tyrosine Excess Seen In:

Hypertthyroidism

Chronic liver disease; cirrhosis

VALINE

Essential - Proteogenic - Glycogenic

Non-Polar, Hydrophobic - Aliphatic

Main Functions:

One of the 3 major Branched-Chain Amino Acids (BCAA) . . .the other 2 being leucine and isoleucine . . . all of which are involved with muscle strength, endurance, and muscle stamina.

BCAA levels are significantly decreased by insulin. High dietary sugar or glucose intake causes release of insulin, which, in turn, causes a drop in BCAA levels.

Competes with Tyrosine and Tryptophan in crossing the blood-brain barrier. The higher the Valine level, the lower the brain levels of Tyrosine and Tryptophan. One of the implications of this competition is that Tyrosine and Tryptophan nutritional supplements need to be taken at least an hour before or after meals or supplements that are high in branched chain amino acids.

Actively absorbed and used directly by muscle as an energy source.

Not processed by the liver before entering the blood stream.

Any acute physical stress (including surgery, sepsis, fever, trauma, starvation) requires higher amounts of Valine, Leucine and Isoleucine than any of the other amino acids.

During period of Valine deficiency, all of the other amino acids (and protein) are less well absorbed by the GI tract.

Valine Deficiency Seen In:

Kwashiorkor

Hunger

Obesity

Neurological deficit

Elevated insulin levels

Valine Excess Seen In:

Ketotic Hypoglycemia

Visual and tactile hallucinations

Minor Amino Acids

There are easily 100 identifiable amino acids, beyond the 20 described within these pages. Being a minor amino acid does not mean their functions are unimportant. In fact, the two minor amino acids you'll read about, Taurine and GABA, are, in fact, extraordinarily important.

GABA

(Gamma Amino Butyric Acid)

Non-Essential - Non-Proteogenic

Main Functions:

One of the two main inhibitory neurotransmitters, the other being Glycine.

Glutamic acid is the main precursor of GABA.

Does not easily pass through the blood-brain barrier, which has important clinical implications.

Although GABA supplementation is used widely for a calming, sedative effect, there is mixed data indicating that GABA taken orally has much clinical effect. Glutamine, a precursor of GABA, readily passes through the blood-brain barrier and is, therefore, a better supplement to take if one wants to increase brain levels of GABA, since Glutamine, once it is in the brain, converts into GABA. The question of GABA's clinical usefulness may be a function of its dosage. That is, it appears that only mega doses of GABA have clinical effects.

Benzodiazepines, such as Valium and Librium, activate GABA neurons.

GABA activity found in glands controlled by the sympathetic nervous system, namely: pancreas and thymus.

Mega-doses of GABA raise IQ.

Mega-doses may be helpful in treating seizure disorders.

GABA Deficiency Seen In:

Seizure disorders

GABA Excess Seen In:

Anxiety

Acute mania

Liver (hepatic) encephalopathy

Cirrhosis

TAURINE

Conditionally-Essential - Non-Proteogenic - Sulfur-Containing

Main Functions:

In the nervous system, stabilizes cell membranes, which raises the seizure threshold, and helps treat epileptic seizures.

Acts as inhibitory neurotransmitter and is as potent as Glycine and GABA.

Anti-convulsant effect is long-lasting and can be confirmed both clinically and by repeat EEG's (electroencephalograms).

Anti-oxidant. Slows down the aging process by neutralizing free radicals.

Highest concentration of Taurine is in the heart.

Reduces risk of gall stones by combining with bile acids to make them water soluble.

Involved in stabilization of heart rhythm. Loss of intracellular Taurine in the heart leads to arrhythmias.

Useful in treatment of Congestive Heart Failure (CHF).

Strengthenes neutrophils (white blood cells/part of immune system) in their ability to kill bacteria.

Useful in brain injury

Decreases cholesterol levels (along with Lysine, Carnitine, and Tryptophan).

Highly concentrated in the eye.

Taurine Deficiency Seen In:

Parkinson's Disease
Anxiety
Candida
AIDS
Cardiac insufficiency
Hypertension
Depression
Kidney failure

Taurine Excess Seen In:

Vitamin B6 deficiency
Rheumatoid arthritis
Zinc deficiency
Liver disease

Predictive Value:

Taurine levels, whether high or low, indicate whether further lab work is needed. For example, if Taurine levels are low and the clinical picture is suggestive of candidiasis, one should test for candida through comprehensive stool analysis and/or anti-candida antibodies.

If Taurine levels are high, zinc and Vitamin B6 levels should be tested. P5P, an important form of Vitamin B6 is necessary for many amino acid reactions to take place.