AMINO ACIDS

BIO 101

AUGUST 4, 2020.

Amino acids are the basic units from which proteins are made. Over 170 amino acids are currently known to occur in cells and tissues. Of these only 20 are commonly found in proteins. Plants are able to make all the amino acids they require from simpler substances. However, animals are unable to synthesize all that they need, and therefore must obtain some readymade amino acids directly from their diet. Amino acids and proteins are the building blocks of life.

When proteins are digested or broken down, amino acids are left. The human body uses amino acids to make proteins to help the body:

Break down food

Grow

Repair body tissue

Perform many other body functions

Amino acids can also be used as a source of energy by the body.

Amino acids are classified into three groups:

1. Essential amino acids

2. Nonessential amino acids

3. Conditional amino acids

ESSENTIAL AMINO ACIDS

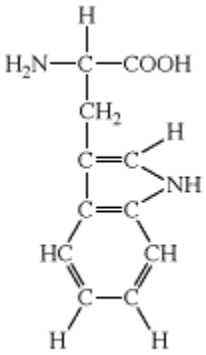
Essential amino acids cannot be made by the body. As a result, they must come from food. The essential amino acids are: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, arginine and valine.

NONESSENTIAL AMINO ACIDS

Nonessential means that our bodies produce an amino acid, even if we do not get it from the food we eat. Nonessential amino acids include: alanine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, and tyrosine.

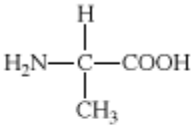
Essential	**Non-essential**
Histidine (H)	Alanine (A)
Isoleucine (I)	Aspartic acid (D)
Leucine (L)	Asparagine (N)
Lysine (K)	Glutamic acid (E)
Methionine (M)	Serine (S)
Phenylalanine (F)	Glycine (G)
Threonine (T)	Proline (P)
Tryptophan (W)	Tyrosine (Y)
Valine (V)	Glutamine (Q)
Arginine (R)	Cysteine (C)

Tryptophan, an amino acid that is nutritionally important and occurs in small amounts in proteins. It is an **essential amino acid**, meaning that humans and certain other animals cannot synthesize it and must obtain it from their diets. Infants require greater amounts of tryptophan than adults to ensure normal growth and development. Tryptophan is used by the body to manufacture several important substances, including the neurotransmitter serotonin and the vitamin niacin. Diets poor in tryptophan can lead to pellagra, a disease resulting from niacin deficiency; however, this disease is now rare in developed countries. In 1901 the English biochemist Frederick G. Hopkins isolated tryptophan from casein, the major protein found in milk.



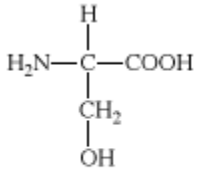
tryptophan

Alanine, either of two amino acids, one of which, L-alanine, or alpha-alanine (α-alanine), is a constituent of proteins. An especially rich source of L-alanine is silk fibroin, from which the amino acid was first isolated in 1879. Alanine is one of several so-called **nonessential amino acids** for birds and mammals; i.e., they can synthesize it from pyruvic acid (formed in the breakdown of carbohydrates) and do not require dietary sources. Alanine, or beta-alanine (β-alanine), is not found in proteins but occurs naturally in two peptides, carnosine and anserine, found in mammalian muscle. It is an important constituent of the vitamin pantothenic acid.



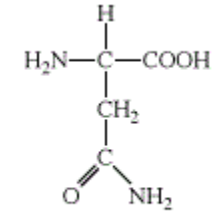
alanine
(Ala, A)

Serine, an amino acid obtainable by hydrolysis of most common proteins, sometimes constituting 5 to 10 percent by weight of the total product. First isolated in 1865 from sericin, a silk protein, serine is one of several so-called **nonessential amino acids** for mammals; i.e., they can synthesize it from glucose and do not require dietary sources. The chemical structure of serine is Serine and some of its derivatives (e.g., ethanolamine) are also important components of a class of lipids (phospholipids) found in biological membranes



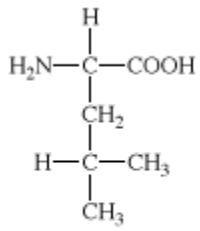
serine
(Ser, S)

Asparagine, an amino acid closely related to aspartic acid, and an important component of proteins. First isolated in 1932 from asparagus, from which its name is derived, asparagine is widely distributed in plant proteins. It is one of several so-called **nonessential amino acids** in warm-blooded animals: they can synthesize it from aspartic acid.



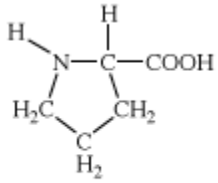
asparagine

Leucine, an amino acid obtainable by the hydrolysis of most common proteins. Among the first of the amino acids to be discovered (1819), in muscle fibre and wool, it is present in large proportions (about 15 percent) in haemoglobin (the oxygen-carrying pigment of red blood cells) and is one of several so-called **essential amino acids** for rats, fowl, and humans; i.e., they cannot synthesize it and require dietary sources. In plants and microorganisms, it is synthesized from pyruvic acid (a product of the breakdown of carbohydrates).



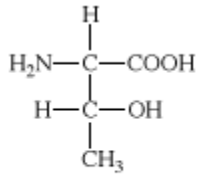
leucine
(Leu, L)

Proline, an amino acid obtained by hydrolysis of proteins. Its molecule contains a secondary amino group (>NH) rather than the primary amino group (>NH2) characteristic of most amino acids. Unlike other amino acids, proline, first isolated from casein (1901), is readily soluble in alcohol. Collagen, the principal protein of connective tissue, yields about 15 percent proline. It is one of several so-called **nonessential amino** acids; i.e., animals can synthesize it from glutamic acid and do not require dietary sources.



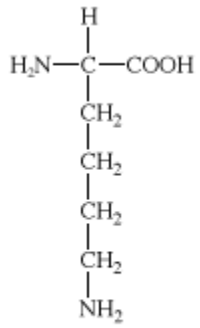
proline
(Pro, P)

Threonine, an amino acid obtainable from many proteins. One of the last amino acids to be isolated (1935), threonine is one of several so-called **essential amino acids**; i.e., animals cannot synthesize it and require dietary sources. It is synthesized in microorganisms from the amino acid aspartic acid.



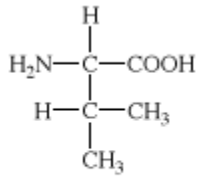
threonine
(Thr, T)

Lysine, an amino acid released in the hydrolysis of many common proteins but present in small amounts or lacking in certain plant proteins; e.g., gliadin from wheat, zein from corn (maize). First isolated from casein (1889), lysine is one of several so-called **essential amino acids** for warm-blooded animals; i.e., they cannot synthesize it and require dietary sources. (It is formed in plants, algae, and fungi by two distinct biosynthetic pathways.) Human populations dependent on grains as a sole source of dietary protein suffer from lysine deficiency.



lysine
(Lys, K)

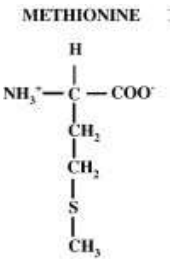
Valine, an amino acid obtained by hydrolysis of proteins and first isolated by the German chemist Emil Fischer (1901) from casein. It is one of several so-called **essential amino acids** for fowl and mammals; i.e., they cannot synthesize it and require dietary sources. It is synthesized in plants and microorganisms from pyruvic acid (a product of the breakdown of carbohydrates).



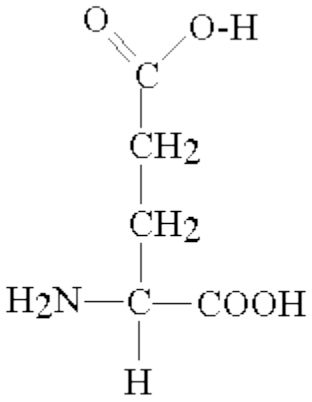
valine
(Val, V)

Isoleucine is an α-amino acid that is used in the biosynthesis of proteins. It contains an α-amino group (which is in the protonated −NH+3 form under biological conditions), an α-carboxylic acid group (which is in the deprotonated −COO− form under biological conditions), and a hydrocarbon side chain with a branch (a central carbon atom bound to three other carbon atoms). It is classified as a non-polar, uncharged (at physiological pH), branched-chain, aliphatic amino acid. It is **essential** in humans, meaning the body cannot synthesize it, and must be ingested in our diet. Isoleucine is synthesized from pyruvate employing leucine biosynthesis enzymes in other organisms such as bacteria.

Methionine is an **essential amino acid** in humans. As the substrate for other amino acids such as cysteine and taurine, versatile compounds such as SAM-e, and the important antioxidant glutathione, methionine plays a critical role in the metabolism and health of many species, including humans.

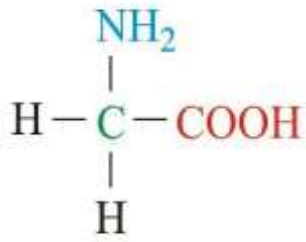


Glutamic acid is an α-amino acid that is used by almost all living beings in the biosynthesis of proteins. It is **non-essential** in humans, meaning the body can synthesize it. It is also an excitatory neurotransmitter, in fact the most abundant one, in the vertebrate nervous system.

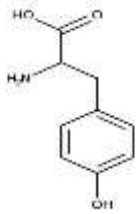


glutamic acid

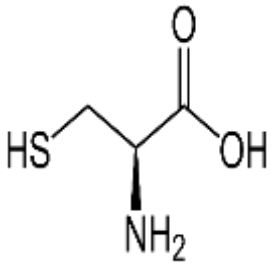
Glycine is an amino acid that has a single hydrogen atom as its side chain. It is the simplest amino acid (since carbamic acid is unstable), with the chemical formula NH2-CH2-COOH. Glycine is one of **non-essential amino acid**. Glycine is integral to the formation of alpha-helices in secondary protein structure due to its compact form. For the same reason, it is the most abundant amino acid in collagen triple-helices. Glycine is also an inhibitory neurotransmitter – interference with its release within the spinal cord (such as during a Clostridium tetani infection) can cause spastic paralysis due to uninhibited muscle contraction.



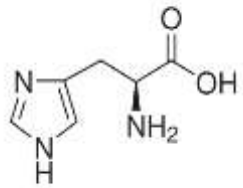
Tyrosine or 4-hydroxyphenylalanine is one of the 20 standard amino acids that are used by cells to synthesize proteins. It is a **non-essential amino acid** with a polar side group. The word "tyrosine" is from the Greek tyrós, meaning cheese, as it was first discovered in 1846 by German chemist Justus von Liebig in the protein casein from cheese. It is called tyrosyl when referred to as a functional group or side chain. While tyrosine is generally classified as a hydrophobic amino acid, it is more hydrophilic than phenylalanine



Cysteine proteinogenic amino acid and it is **non-essential amino acid**. The thiol side chain in cysteine often participates in enzymatic reactions, as a nucleophile. The thiol is susceptible to oxidation to give the disulfide derivative cystine, which serves an important structural role in many proteins.

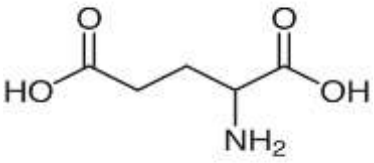


Histidine is an **essential amino acid** (children should obtain it from food) needed in humans for growth and tissue repair, Histidine is important for maintenance of myelin sheaths that protect nerve cells and is metabolized to the neurotransmitter histamine. Histamines play many roles in immunity, gastric secretion, and sexual functions. Histidine is also required for blood cell manufacture and protects tissues against damage caused by radiation and heavy metals.

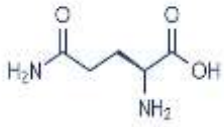


Aspartic acid (the ionic form is known as aspartate), is an α-amino acid that is used in the biosynthesis of proteins. Like all other amino acids, it contains an amino group and a carboxylic acid. Its α-amino group is in the protonated –NH+3 form under physiological conditions, while its α-carboxylic acid group is deprotonated −COO− under physiological conditions. Aspartic acid has an acidic side chain (CH2COOH) which reacts with other amino acids, enzymes and proteins in the body. Under physiological conditions (pH 7.4)

in proteins the side chain usually occurs as the negatively charged aspartate form, −COO−. It is a **non-essential amino acid** in humans, meaning the body can synthesize it as needed.



Glutamine is an α-amino acid that is used in the biosynthesis of proteins. Its side chain is similar to that of glutamic acid, except the carboxylic acid group is replaced by an amide. It is classified as a charge-neutral, polar amino acid. It is **non-essential** meaning the body can usually synthesize sufficient amounts of it, but in some instances of stress, the body's demand for glutamine increases, and glutamine must be obtained from the diet.



glutamine

Phenylalanine is an **essential** α-amino acid. It can be viewed as a benzyl group substituted for the methyl group of alanine, or a phenyl group in place of a terminal hydrogen of alanine. This essential amino acid is classified as neutral, and nonpolar because of the inert and hydrophobic nature of the benzyl side chain. The L-isomer is used to biochemically form proteins, coded for by DNA. Phenylalanine is a precursor for tyrosine, the monoamine neurotransmitters dopamine, norepinephrine (noradrenaline), and epinephrine (adrenaline), and the skin pigment melanin.