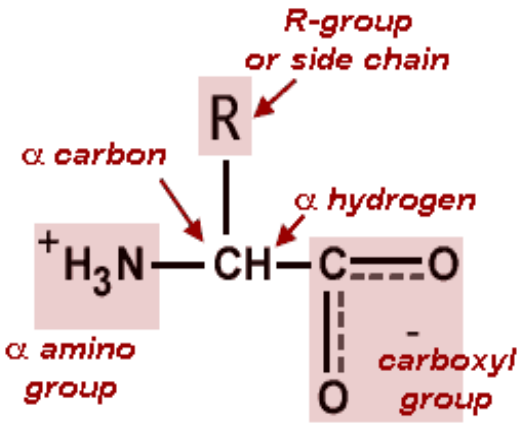
AMINO ACID: STRUCTURE AND CLASSIFICATION

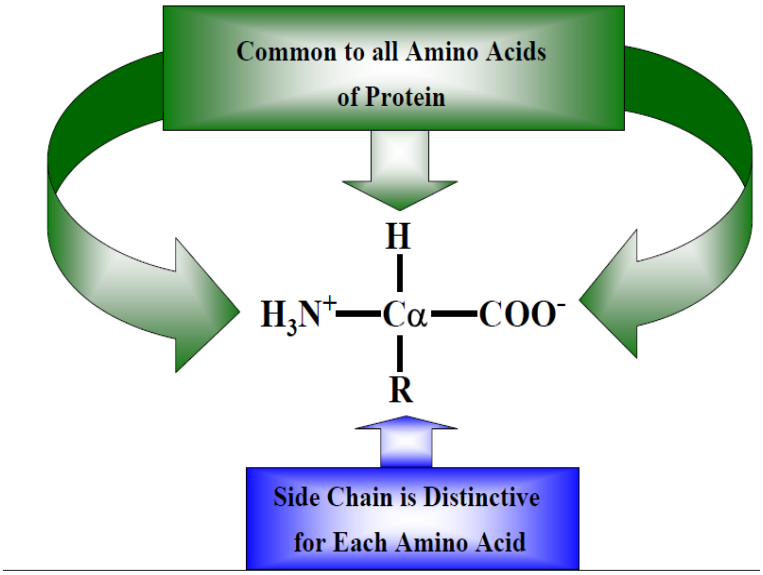
Amino Acids are the building units of proteins. There are about 300 amino acids occur in nature. Only 20 of them enter in proteins synthesis.

Structure of amino acids:

Each amino acid has 4 different groups attached to α- carbon (which is C-atom next to COOH). These 4 groups are: amino group, COOH group, Hydrogen atom and side Chain (R). At physiological pH (7.4), -COOH group is dissociated forming a negatively charged carboxylate ion (COO-) and amino group is protonated forming positively charged ion ($NH3^{+}$) forming Zwitter ion .

• Proline is an imino acid not amino acid.





Classification of Amino Acids:

I. Classification by R group
II. Chemical Classification
III. Nutritional Classification
IV. Metabolic Classification

Classification according to polarity of side chain (R):

A- Polar amino acids: in which R contains polar hydrophilic group so can forms hydrogen bond with H2O. In those amino acids, R may contain:

1- OH group : as in serine, threonine and tyrosine
2- - SH group : as in cysteine
3- amide group: as in glutamine and aspargine
4- NH2 group or nitrogen act as a base (basic amino acids): as lysine, arginine and histidine
5- COOH group (acidic amino acids): as aspartic and glutamic.

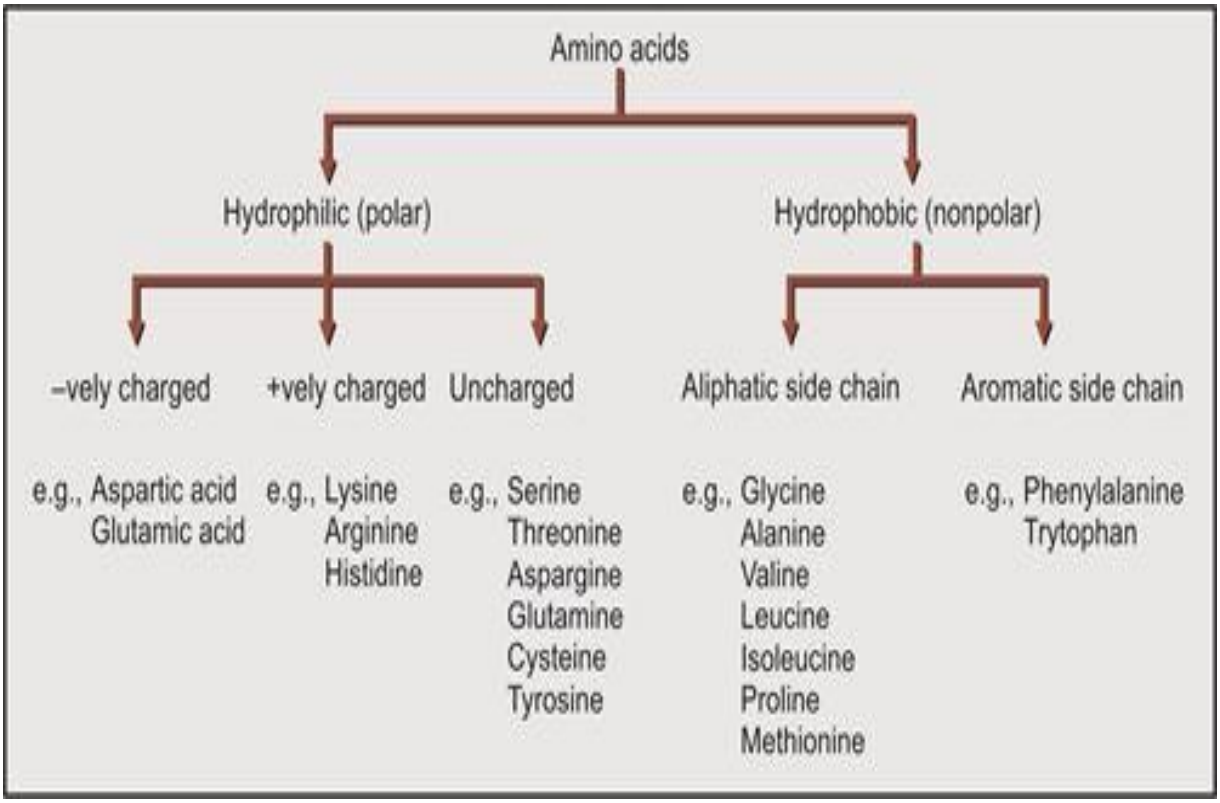


Figure: Classification by R group

B- Non polar amino acids: R is alkyl hydrophobic group which can't enter in hydrogen bond formation. 9 amino acids are non-polar (glycine, alanine, valine, leucine, isoleucine, phenyl alanine, tryptophan, proline and methionine).

The ***twenty common amino acids*** are often referred to using three-letter abbreviations. The structures, names, and abbreviations for the twenty common amino acids are shown below. Note that they are all ***α*-amino acids**.

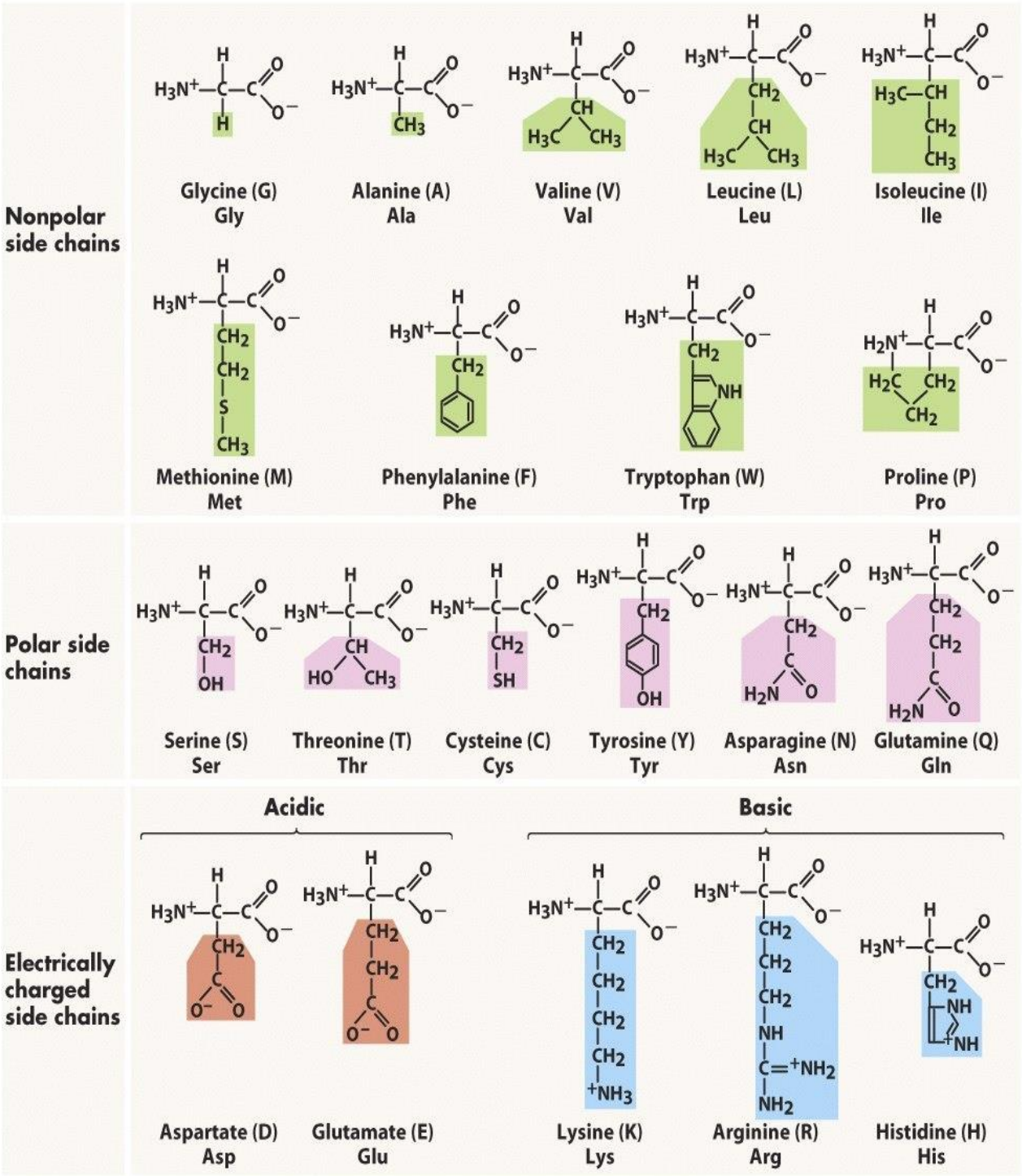


Figure 3-5 Biological Science, 2/e

Each amino acid, aside from its name, has a three letter abbreviation and a one letter code.

Nomenclature

Amino Acid	3 letter code	1 letter code	Amino Acid	3 letter code	1 letter code
Glycine	Gly	G	Threonine	Thr	T
Alanine	Ala	A	Cysteine	Cys	C
Valine	Val	V	Tyrosine	Tyr	Y
Leucine	Leu	L	Asparagine	Asn	N
Isoleucine	Ile	I	Glutamine	Gln	Q
Methionine	Met	M	Aspartic Acid	Asp	D
Proline	Pro	P	Glutamic Acid	Glu	E
Phenyl alanine	Phe	F	Lysine	Lys	K
Tryptophan	Trp	W	Arginine	Arg	R
Serine	Ser	S	Histidine	His	H

Nutritional Classification

1- Essential Amino Acids can’t be synthesized in the body, essential to be taken in diet. Their deficiency affects growth, health and protein synthesis. Thus, Isoleucine, Leucine, Threonine, Lysine, Methionine, Phenylalanine, Tryptophan, and Valine are essential amino acids

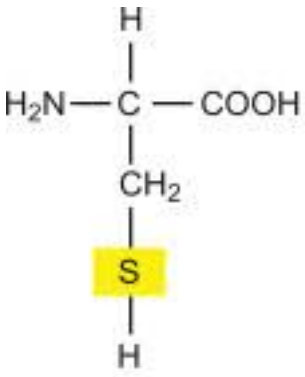
2- Semi-essential formed in the body but not in sufficient amount for body requirements especially in children. Arginine and histidine are semi-essential

3- Non-essential can be synthesized in the body. The non-essential amino acids are Alanine, Asparagine, Aspartic acid, Cysteine, Glutamine, Glutamic Acid, Glycine, Proline, Serine and Tyrosine. All body proteins do contain all the non-essential amino acids.

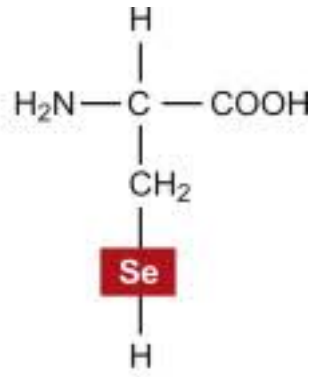
Non-Standard Amino Acids

The standard number of amino acids that are commonly found in proteins is 20. These are known as the proteinogenic amino acids, which are encoded by the genetic code. However, there are a few additional amino acids that are sometimes included in discussions:

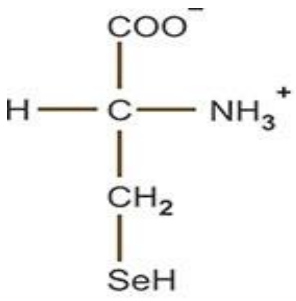
- Selenocysteine (21st amino acid): Often referred to as the 21st amino acid, selenocysteine is incorporated into proteins via a specific mechanism that involves a unique codon (UGA) and requires a special translation factor. It contains selenium instead of sulfur, which is found in cysteine.
- Pyrrolysine (22nd amino acid): Pyrrolysine is considered the 22nd amino acid and is found in some archaea and bacteria. It is encoded by the UAG codon in specific contexts and is involved in certain enzymatic functions.
- Other non-standard amino acids: There are also non-standard amino acids that are not incorporated into proteins but may play important roles in metabolism or signaling, such as ornithine and citrulline. These are not included in the standard count of amino acids used in protein synthesis.



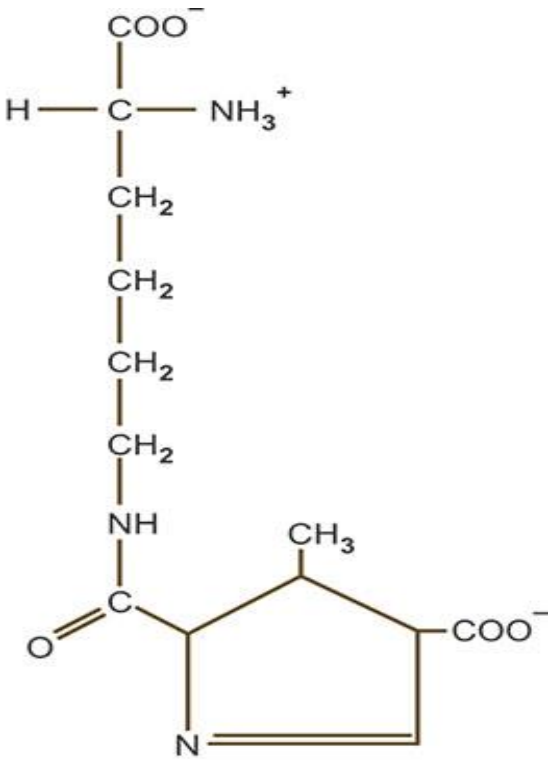
CYSTEINE



SELENOCYSTEINE



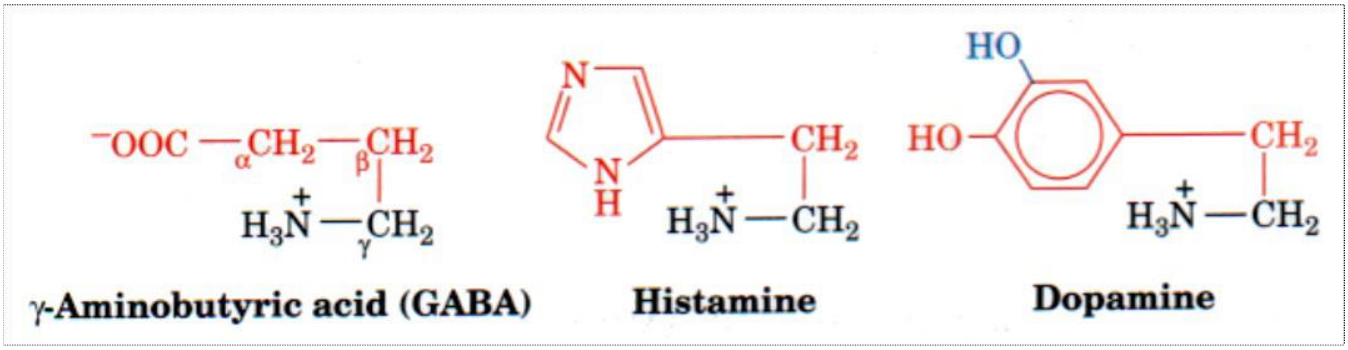
Selenocysteine



Pyrrolysine

Amino Acid Derivatives

Chemical derivatives of amino acids also have important biological functions, eg. Catecholamines (below) lack the carboxylate of amino acids



GABA & Dopamine are neurotransmitters. Histamine mediates parts of the immune response.

Functions of Amino Acids

Apart from being the monomeric constituents of proteins and peptides, amino acids serve variety of functions.

(a) Some amino acids are converted to carbohydrates and are called as **glucogenic amino acids**.

(b) Specific amino acids give rise to specialized products, e.g.

• **Tyrosine** forms hormones such as **thyroid hormones**, (T3, T4), **epinephrine** and **norepinephrine** and a pigment called **melanin**.

• **Tryptophan** can synthesize a vitamin called **niacin**.

• Glycine, arginine and methionine synthesis **creatine**.

• Glycine and cysteine help in **synthesize of Bile salts**.

• Glutamate, cysteine and glycine synthesis **glutathione**.

• **Histidine** changes to **histamine** on decarboxylation.

• **Serotonin** is formed from tryptophan.

• Glycine is used for the synthesis of **haem**.

• Pyrimidines and purines use several amino acids for their synthesis such as aspartate and glutamine for pyrimidines and glycine, aspartic acid, Glutamine and serine for purine synthesis.

(c) Some amino acids such as glycine and cysteine are used as detoxicants of specific substances.

(d) Methionine acts as "active" methionine (S-adenosylmethionine) and transfers methyl group to various substances by transmethylation.

(e) Cystine and methionine are sources of Sulphur.