Al-Mustaqbal University

College of Engineering & Technology

Biomedical Engineering Department

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Lecture No.: 2

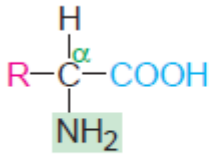
Lecture Title: [Amino acids & peptides]

Amino acids & peptides

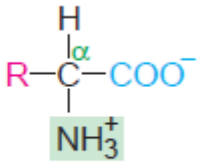
Amino acids are a group of organic compounds containing two functional groups (amino and carboxyl). The amino group (—NH_2) is basic while the carboxyl group (—COOH) is acidic in nature.

General structure of amino acids

The amino acids are termed as α-amino acids, if both the carboxyl and amino groups are attached to the same carbon atom, as depicted below



General structure



Exists as ion

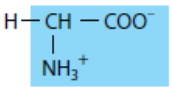
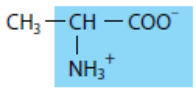
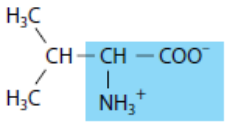
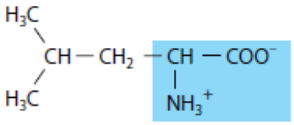
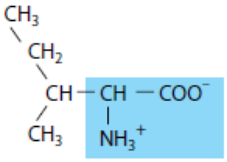
The α-carbon atom binds to a side chain represented by R which is different for each of the 20 amino acids found in proteins. The amino acids mostly exist in the ionized form in the biological system.

20 amino acids are required for the synthesis of variety proteins, besides other biological functions. However, all these 20 amino acids need not be taken in the diet. Based on the nutritional requirements, amino acids are grouped into two classes—essential and nonessential.

Classification of amino acids

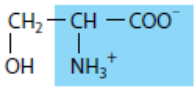
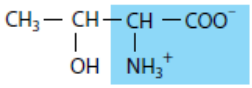
1. **Amino acids with aliphatic side chains:**

These are mono-amino monocarboxylic acids. This group consists of the most simple amino acids-glycine, alanine, valine, leucine and isoleucine. The last three amino acids (Leu, Ile, Val) contain branched aliphatic side chains.

Name	Symbol	Structural Formula	pK_1	pK_2	pK_3
With Aliphatic Side Chains			α-COOH	α-NH_3^+	R Group
Glycine	Gly [G]		2.4	9.8	
Alanine	Ala [A]		2.4	9.9	
Valine	Val [V]		2.2	9.7	
Leucine	Leu [L]		2.3	9.7	
Isoleucine	Ile [I]		2.3	9.8	

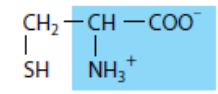
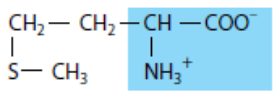
2. **Hydroxyl group containing amino acids :**

Serine, threonine and tyrosine are hydroxyl group containing amino acids. Tyrosine—being aromatic in nature—is usually considered under aromatic amino acids.

With Side Chains Containing Hydroxylic (OH) Groups					
Serine	Ser [S]		2.2	9.2	about 13
Threonine	Thr [T]		2.1	9.1	about 13
Tyrosine	Tyr [Y]	See below.			

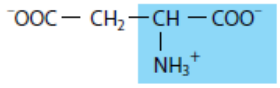
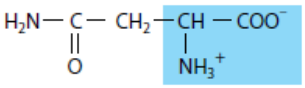
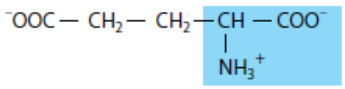
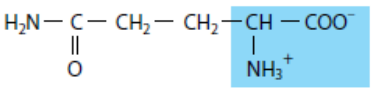
3. **Sulfur containing amino acids :**

Cysteine with sulfhydryl group and methionine with thioether group are the two amino acids incorporated during the course of protein synthesis. Cystine, another important sulfur containing amino acid, is formed by condensation of two molecules of cysteine.

With Side Chains Containing Sulfur Atoms					
Cysteine	Cys [C]		1.9	10.8	8.3
Methionine	Met [M]		2.1	9.3	

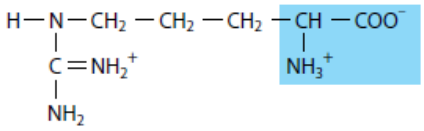
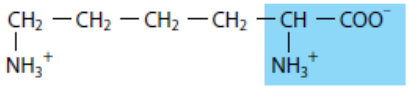
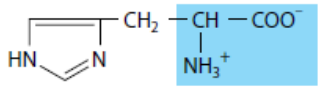
4. **Acidic amino acids and their amides :**

Aspartic acid and glutamic acids are **dicarboxylic monoamino acids** while asparagine and glutamine are their respective amide derivatives. All these four amino acids possess distinct codons for their incorporation into proteins.

With Side Chains Containing Acidic Groups or Their Amides					
Aspartic acid	Asp [D]		2.0	9.9	3.9
Asparagine	Asn [N]		2.1	8.8	
Glutamic acid	Glu [E]		2.1	9.5	4.1
Glutamine	Gln [Q]		2.2	9.1	

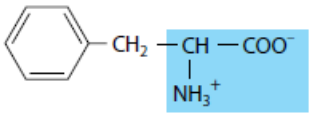
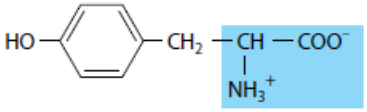
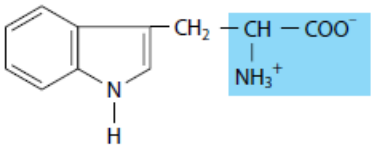
5. **Basic amino acids :**

The three amino acids lysine, arginine (with guanidino group) and histidine (with imidazole ring) are dibasic monocarboxylic acids. They are highly basic in character.

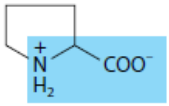
With Side Chains Containing Basic Groups			α-COOH	α-NH_3^+	R Group
Arginine	Arg [R]		1.8	9.0	12.5
Lysine	Lys [K]		2.2	9.2	10.8
Histidine	His [H]		1.8	9.3	6.0

6. **Aromatic amino acids :**

Phenylalanine, tyrosine and tryptophan (with indole ring) are aromatic amino acids. Besides these, histidine may also be considered under this category.

Containing Aromatic Rings					
Histidine	His [H]	See above.			
Phenylalanine	Phe [F]		2.2	9.2	
Tyrosine	Tyr [Y]		2.2	9.1	10.1
Tryptophan	Trp [W]		2.4	9.4	

7. **Imino acids :** Proline containing pyrrolidine ring is a unique amino acid. It has an imino group (=NH), instead of an amino group (-NH2) found in other amino acids. Therefore, proline is an α-imino acid.

Imino Acid				
Proline	Pro [P]		2.0	10.6

Properties of amino acids

The amino acids differ in their physico–chemical properties which ultimately determine the characteristics of proteins.

A. Physical properties

1. **Solubility :** Most of the amino acids are **usually soluble in water** and insoluble in organic solvents.

2. **Melting points :** Amino acids generally melt at higher temperatures, often above 200°C.

3. **Taste :** Amino acids may be sweet (Gly, Ala, Val), tasteless (Leu) or bitter (Arg, Ile).

4. **Optical properties :** All the amino acids **except glycine** possess optical isomers due to the presence of asymmetric carbon atom. Some amino acids also have a second asymmetric carbon e.g. isoleucine, threonine.

5. **Amino acids as ampholytes :** Amino acids contain both acidic (COOH) and basic