Amino Acids

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Aims of The Lecture

The students should be learning about Amino acids:

- **The structures**
- **Types**
- **Optical properties.**
- **Electrophoresis**
- **The importance and functional role.**

Amino acid

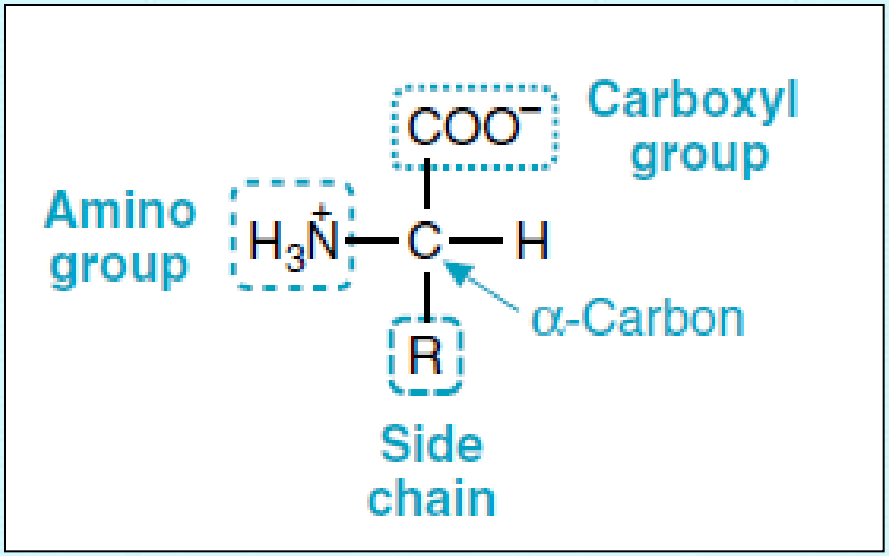
- **Amino Acids are the building units of proteins. Proteins are polymers of amino acids linked together by what is called " Peptide bond".**
- **There are about 300 amino acids occur in nature. Only 20 of them occur in proteins.**

STRUCTURE OF THE AMINO ACIDS

Each amino acid (except for proline) has:

1. A carboxyl group ($-COO^-$) .
2. An amino group ($-NH_3^+$) .
3. Side chain ("R-group") bonded to the α-carbon atom.

These carboxyl and amino groups are combined in peptide linkage.


COO⁻
Carboxyl group
Amino group
H3N+
C
H
α-Carbon
R
Side chain

Classification of Amino Acids

They classified according to the side chain:

- Essential and non essential.
- Amino acids with nonpolar side chains.
- Aromatic R Groups.
- Amino acids with uncharged polar side chains.
- Positively Charged (Basic) R Groups.
- Amino acids with acidic side chains.

- **1- Essential amino acids:** These amino acids can't be formed in the body and so, it is essential to be taken in diet. Their deficiency affects growth, health and protein synthesis.
- **2- Semiessential amino acids:** These are formed in the body but not in sufficient amount for body requirements especially in children.
- Summary of essential and semiessential amino acids:
- V= valine i= isoleucine l= lysine l= leucine
- A = arginine* H= histidine* M= methionine
- T= tryptophan Th= threonine P= phenyl alanine
- arginine and histidine are semiessential
- **3- Non essential amino acids:** These are the rest of amino acids that are formed in the body in amount enough for adults and children. They are the remaining 10 amino acids.

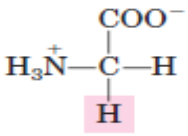
A- Nonpolar Side Chains

- The side chains cluster in the interior of the protein due to hydrophobicity.
- The side chain of **proline** and its α-amino group form a ring structure.
- **Proline** gives the fibrous structure of collagen, and interrupts the α-helices found in globular proteins.

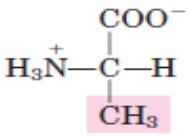
B- Aromatic (R) Groups

- Their aromatic side chains, are nonpolar so that participate in hydrophobic interactions.
- Tyrosine is an important in some enzymes.
- Most proteins absorb light at a wavelength of 280 nm due to aromatic groups.
- A property exploited by researchers in the characterization of proteins.

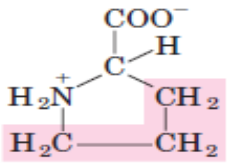
Nonpolar, aliphatic R groups



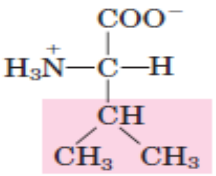
Glycine



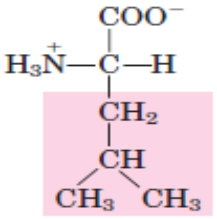
Alanine



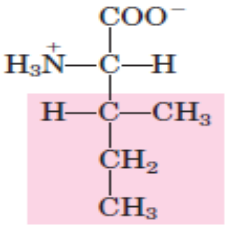
Proline



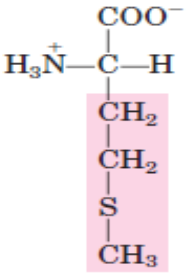
Valine



Leucine

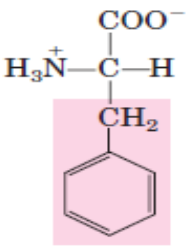


Isoleucine

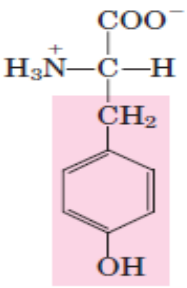


Methionine

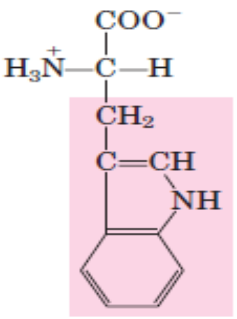
Aromatic R groups



Phenylalanine

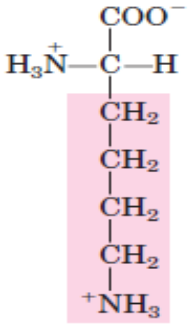


Tyrosine

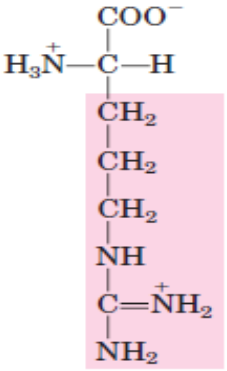


Tryptophan

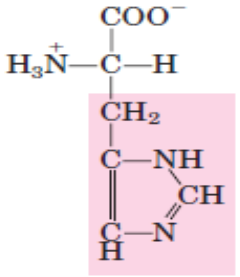
Positively charged R groups



Lysine

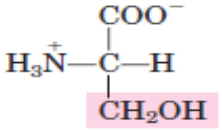


Arginine

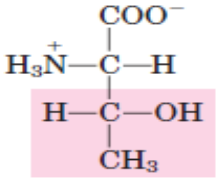


Histidine

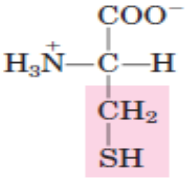
Polar, uncharged R groups



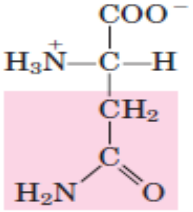
Serine



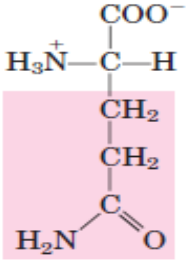
Threonine



Cysteine

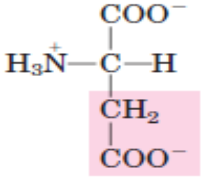


Asparagine

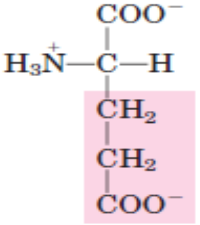


Glutamine

Negatively charged R groups



Aspartate

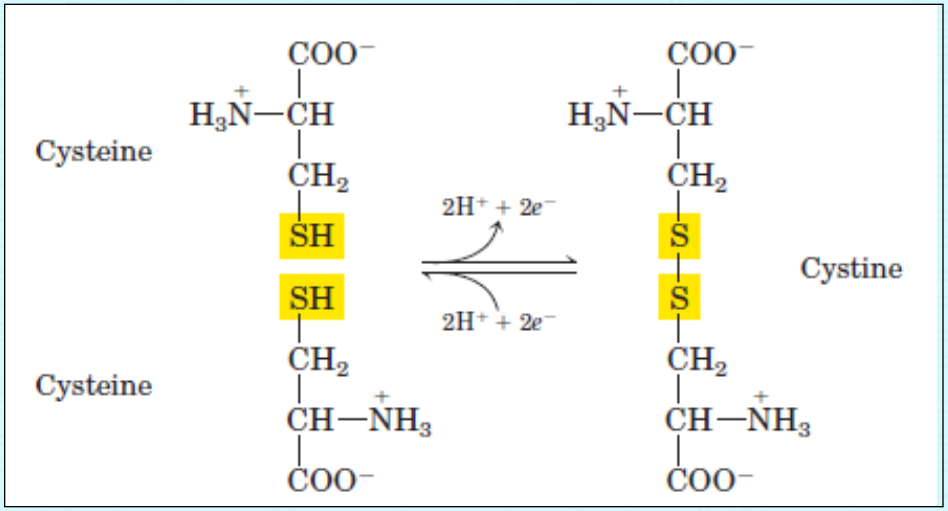


Glutamate

C. Uncharged polar side chains

- More hydrophilic because they form hydrogen bonds with water.
- includes **serine, threonine, cysteine, asparagine,** and **glutamine.**
- **Cysteine** contains a **sulfhydryl group** (-SH), an important component of the active site of many enzymes.
- Two cysteines can become oxidized to form a dimmer **cystine,** which contains a covalent cross-link called a disulfide bond (-S-S-).

- Serine and threonine contain a **polar hydroxyl group.**
- Serve as a site of attachment (in enzymes) for groups such as a phosphate.
- **Amide group** of asparagine, as well as the hydroxyl group of serine or threonine serve as a site of attachment for oligosaccharide chains in glycoproteins.



D. Basic (R) Groups

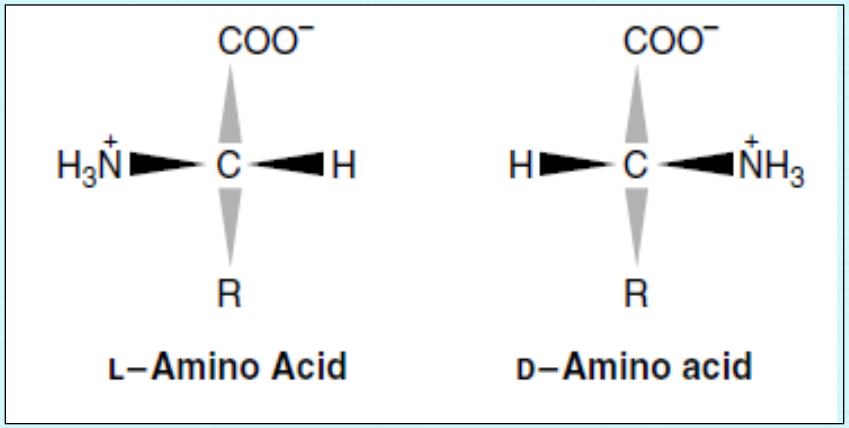
- The R groups have significant positive charge.
- **Lysine** has a second positive amino group at the ε position on its (R) chain.
- **Arginine** has a positively charged guanidino group.
- **Histidine** has a positive imidazole group facilitates the enzyme-catalyzed reaction by serving as a proton donor/acceptor.

E. Acidic Side Chains

- Aspartic and glutamic acid are proton donors.
- At neutral pH, the side chains of these amino acids are fully ionized.
- They have a negatively charged carboxylate group (-COO^-) at physiologic pH.

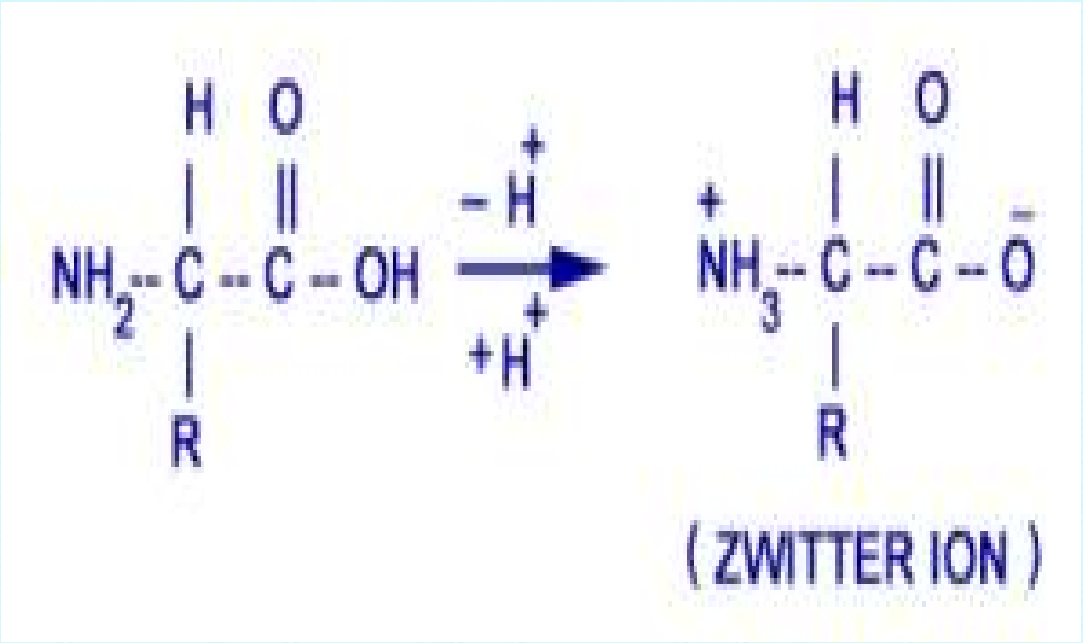
Optical Properties of Amino Acids

- The α-carbon of a.a. is attached to four different chemical groups is a chiral or optically active carbon atom.



- Glycine is the exception.
- amino acids exist in two forms, D and L, that are mirror images of each other.
- All amino acids found in proteins are of the L-configuration.

- **Amphoteric properties of amino acids:** that is they have both basic and acidic groups and so can act as base or acid.
- Neutral amino acids (monobasic, monocarboxylic) exist in aqueous solution as “ Zwitter ion” i.e. contain both positive and negative charge. Zwitter ion is electrically neutral and can’t migrate into electric field.


H O
NH2 C C OH
R
− H+
+H+
H O
+ NH3 C C O−
R
(ZWITTER ION)

Isoelectric point

- The **isoelectronic point** or **isoionic point** is the pH at which the amino acid does not migrate in an electric field. This means it is the pH at which the amino acid is neutral, *i.e.* the zwitterion form is dominant.

pK and pI value of aminoacids

Name	pK			pI
	pK α-CO2H	pK NH3	pK R-group	at 25°C
Alanine	2.35	9.87		6.11
Arginine	2.18	9.09	13.2	10.76
Asparagine	2.18	9.09	13.2	10.76
Aspartic Acid	1.88	9.60	3.65	2.98
Cysteine	1.71	10.78	8.33	5.02
Glutamic Acid	2.19	9.67	4.25	3.08
Glutamine	2.17	9.13		5.65
Glycine	2.34	9.60		6.06
Histidine	1.78	8.97	5.97	7.64
Isoleucine	2.32	9.76		6.04
Leucine	2.36	9.60		6.04
Lysine	2.20	8.90	10.28	9.47
Methionine	2.28	9.21		5.74
Phenylalanine	2.58	9.24		5.91
Proline	1.99	10.60		6.30
Serine	2.21	9.15		5.68
Threonine	2.15	9.12		5.60
Tryptophan	2.38	9.39		5.88
Tyrosine	2.20	9.11	10.07	5.63
Valine	2.29	9.74		6.02

Electrophoresis

- Is a process of separation and purification of compounds on the basis of movement of charged particles in an electric field.
- Amino acid whose electric point is below the pH of buffer migrate towards positive electrode because they exist in anionic form.
- Amino acid whose electric point is above the pH of buffer migrate towards negative electrode because they exist in cationic form.
- Amino acid whose electric point is corresponds to the pH of buffer donot migrate because they have no net charge.

Refrences

- https://en.wikipedia.org/wiki/Zwitterion
- https://www.britannica.com/science/amino-acid
- https://en.wikipedia.org/wiki/Amino_acid
- http://www.chem.ucalgary.ca/courses/351/Carey5th/Ch27/ch27-1-4.html

Thank you