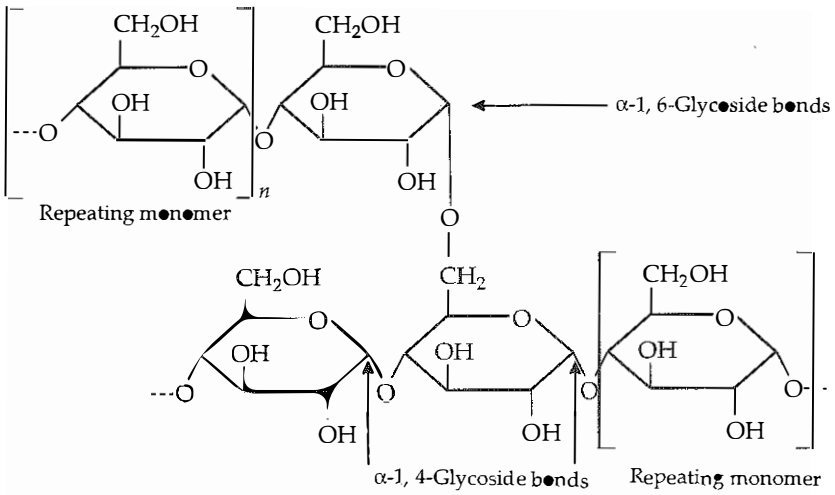


Structure of amylopectin

- **Uses :** Starch and its derivatives are used
  - As the most valuable constituent of food as rice, bread, potato and corn-flour, etc.
  - In the manufacture of glucose, dextrin and adhesives (starch paste).
  - In paper and textile industry.
  - In calico printing as a thickening agent for colours.
  - Nitro starch is used as an explosive.
  - Starch-acetate is a transparent gelatin like mass and is used mainly for making sweets.

Cellulose

- It is the structural material of cell walls of all the plants. It is also the chief component of cotton, wood and jute. Cellulose on hydrolysis gives only β-*D*-(+)-glucose and thus, it is entirely composed of *D*-(+)-glucose units. β-*D*-(+)-glucose units in cellulose are joined by another linkage between C-1 of one glucose unit and C-4 of the next glucose unit. The molecular mass of cellulose 50,000 to 5,00,000 which corresponds to 300-3500 *D*-(+)-glucose units joined together. Wood is a combination of cellulose and lignin.

$$\underset{\text{Cellulose}}{(C_6H_{10}O_5)_n} + nH_2O \longrightarrow \underset{\text{Glucose}}{nC_6H_{12}O_6}$$

- **Uses**
  - Used as explosive in the form of gun cotton.
  - As cellulose acetate, it is used in plastics, wrapping films, nail polish, etc.
  - As ethyl cellulose, it is used in plastic coats and films.
  - As methyl cellulose, it is used in fabric sizing, cosmetics and pastes.
  - In manufacture of celluloid, rayon and cellophane.
  - Cellulose fibers from cotton are used to produce threads, textiles and ropes.
  - Used for paper making.
  - Finely divided cellulose is used for making card board, hard board, etc.

Glycogen

- Glycogen or animal starch $(C_6H_{10}O_5)n$ occurs in the liver, muscles, white corpuscles of blood and also in some fungi and bacteria. It is a reserve food in animals. It releases energy by oxidation to lactic acid in times of need. It is a white powder and dextrorotatory. It's aqueous solution gives reddish brown colour with iodine, glycogen is resistant to boiling aqueous alkalies. It resembles amylopectin and has a branched structure.

PROTEINS

- Proteins are high molecular mass complex biomolecules of amino acids present in all living cells. They are vital chemical substances essential for growth and maintenance of life.
- All proteins on partial hydrolysis give peptides of varying molecular masses which on complete hydrolysis give α-amino acids.
- Amino acids are organic compounds containing both an amino group and a carboxylic group.

$$R-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$$

α-Amino acids are those, in which the amine group is located on the carbon atom adjacent to the carboxyl group (α-carbon atom).

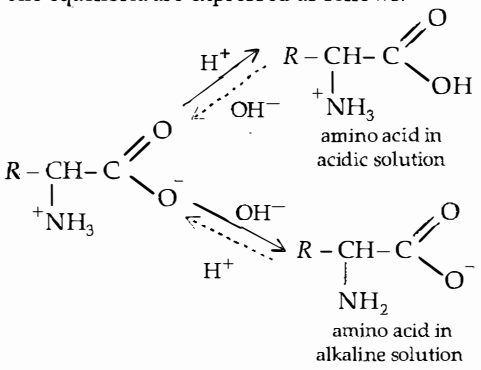
Physical Properties of α-Amino acids

- Amino acids are usually colourless, crystalline and water soluble high melting solids.
- They behave like salts due to presence of basic amino group ($-NH_2$) and acidic carboxylic group ($-COOH$) in the same molecule.
- In aqueous solution the carboxylic group can lose a proton and amino group can accept a proton giving rise to a dipolar ion known as zwitter ion. This is neutral but contains both positive and negative charges.

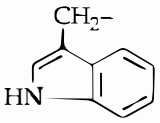
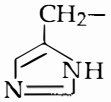
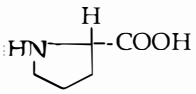
$$R-\underset{\displaystyle NH_2}{\underset{|}{\overset{\displaystyle O}{\overset{||}{CH}}}}-C-OH \rightleftharpoons R-\underset{\displaystyle \overset{\oplus}{N}H_3}{\underset{|}{\overset{\displaystyle O}{\overset{||}{CH}}}}-C-O^{\ominus}$$

Chemical Properties of α-Amino Acids

- Since these form salts with acids as well as with bases, their chemical reactions are similar to primary amines and carboxylic acids. Compounds which exhibit acidic and basic properties are called amphoteric substances and the phenomenon is known as amphoterism.
- The equilibria are expressed as follows:



- **Isoelectric point** : The pH at which dipolar ion (zwitter ion) exists as neutral ion, *i.e.*, +ve and –ve charge is equal and it does not migrate to either electrode, is called isoelectric point. The amino acids have least solubility at isoelectric point which helps in their separation. pH = 5.5 to 6.3 is isoelectric point for amino acids.
- **Optical activity of amino acids** : All amino acids except glycine are optically active because they contain chiral, asymmetric carbon atom. They exist in both *D* and *L*-forms. Most naturally occurring amino acids have *L*-configuration.
- There are about 20 amino acids which make up the bioproteins. Out of these 10 amino acids **(non-essential)** are synthesised by our bodies and rest are essential in the diet **(essential amino acids)** and supplied to our bodies by food which we take because they cannot be synthesised in the body.

	Name of amino acid	Structure of *R*	Three letter symbol
1	Glycine	–H	Gly
2	Alanine	$-CH_3$	Ala
*3	Valine	$-CH(CH_3)_2$	Val
*4	Leucine	$-CH_2CH(CH_3)_2$	Leu
*5	Isoleucine	$-CH(CH_3)CH_2CH_3$	Ile
*6	Arginine	$-(CH_2)_3NH-C(=NH)-NH_2$	Arg
*7	Lysine	$-(CH_2)_4NH_2$	Lys
8	Glutamic acid	$-CH_2CH_2COOH$	Glu
9	Aspartic acid	$-CH_2COOH$	Asp
10	Glutamine	$-CH_2CH_2CONH_2$	Gln
11	Asparagine	$-CH_2CONH_2$	Asn
*12	Threonine	$-CHOH.CH_3$	Thr
13	Serine	$-CH_2OH$	Ser
14	Cysteine	$-CH_2SH$	Cys
*15	Methionine	$-CH_2CH_2SCH_3$	Met
*16	Phenylalanine	$-CH_2C_6H_5$	Phe
17	Tyrosine	$-CH_2C_6H_4OH(p)$	Tyr
*18	Tryptophan		Trp
*19	Histidine		His
*20	Proline		Pro

*Essential amino acids

- Peptides are compounds formed by the condensation of two or more, same or different α-amino acids. When the amino acids condense water molecules are eliminated, the resulting –CO–NH– linkage is called a **peptide linkage or peptide bond**.
- If a large number of α-amino acids are joined together by peptide bonds, the resulting polyamide is called a **polypeptide**.

$$H_2N-CHR-CO\left[-NH-CHR-CO\right]_n$$

Structure of Proteins

- **Primary structure** : The sequence in which various amino acids are arranged in a protein is known as the primary structure of a protein. The number, sequence and identity of amino acids in a protein constitute primary structure of a protein.
- **Secondary structure** : The coiling of the long strings of amino acids in a protein is its secondary structure. The α-helix is a common secondary structure. In α-helix, the peptide chain coils and the turns of the coil are held together by hydrogen bonds. Another type of secondary structure is possible in which the protein chains are stretched out. It is a β-pleated sheet structure.
- **Tertiary structure** : The folding and binding of α-helix into more complex shapes illustrates the tertiary structure of proteins. At normal pH and temperature, each protein will take the energetically most stable shape. This shape is specific to a given amino acids which form proteins.
- **Quaternary protein structure** results when several protein molecules are bonded together to form a still larger units.