Proteins And Amino Acids

Introduction:- (Protein)

* The name protein is derived from the Greek word proteios, meaning the first (and foremost).
* Proteins are a class of chemicals, which occupy the foremost position among biological chemicals.
* It is also believed that origin of life was made possible because of amino-acids, which are the building blocks of all proteins.

Functions of proteins:- Proteins have two major function in all living cells or tissues or organs:-

① Structural
② Dynamic

① **Structural :-** Structural proteins have rigid, usually fibrous form and support the physical framework of living beings

eg:- connective tissue.
cell membrane.
muscle fibre.

② **Dynamic :-** Dynamic proteins are responsible for all active life processes like:-

* Biochemical Reactions. (metabolism)
* Control of Body functions.

* protection of cells and tissues against foreign organism
* transport of other chemicals
* maintenance of favourable physico-chemical condition like — osmotic pressure, viscosity.

* Examples of proteins involved in these dynamic functions include —
  1. Enzymes
  2. Hormones
  3. antibodies
  4. Hemoproteins
  5. serum proteins

Properties of proteins :-

* Proteins have a high molecular weight.
* most proteins are amorphous solids, but a few have been crystallized.
* On breakdown (usually hydrolysis) they yield a mixture of amino-acids.

Classification of proteins.

(1) simple proteins :-

made up of only α-amino acids —

Class	characteristics	Examples.
1) Albumins.	soluble in water & dilute electrolyte solutions	egg albumin Serum albumin

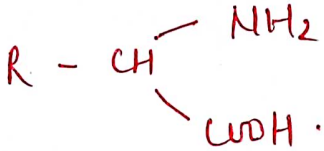
b) Globulins	sparingly soluble in water but soluble in dilute electrolyte soln.	serum globulin ②
c) Prolamines	Insoluble in water, soluble in 70% alcohol.	seed proteins
d) Glutelins	soluble only in acidic or alkaline media	wheat gluten.
e) Scleroproteins (Albuminoids)	Insoluble in aqueous media	hair, nails
f) Protamines	Highly basic	sperm proteins
g) Histones	Less basic than protamines	thymus gland proteins.

② Complex or Conjugated proteins – Contain also other compounds and metals.

Class	Characteristics	Examples
a) Glycoproteins.	sugar residues are present	Blood group Proteins.
b) Lipoproteins.	Lipids are present	egg yolk.
c) Nucleoproteins.	Nucleic acids are present	virus proteins
d) Metalloproteins	Metal ions are present	cytochromes.
e) chromoproteins	Coloured organic compounds are associated	Hemoglobin

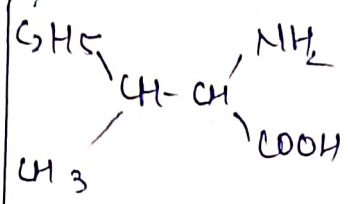
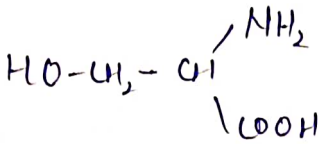
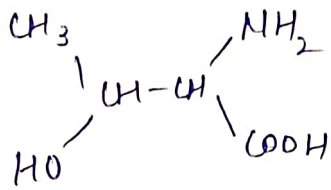
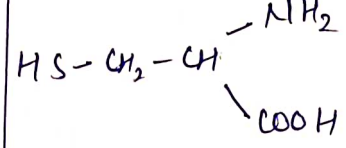
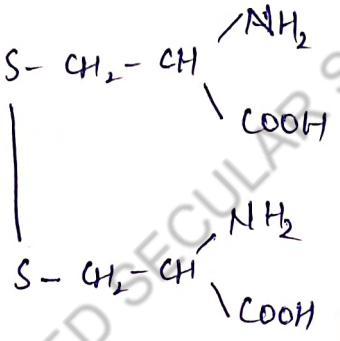
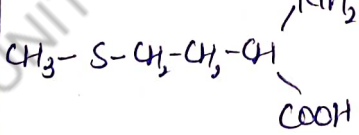
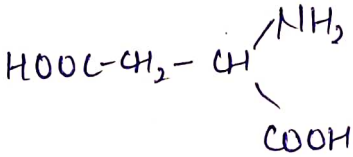
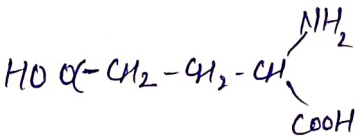
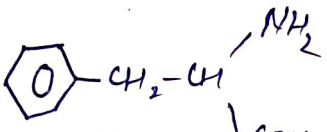
Amino Acids.

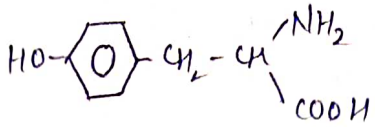
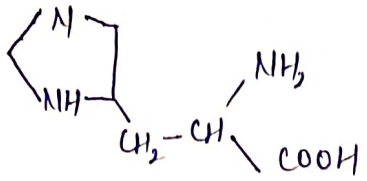
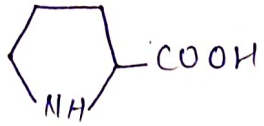
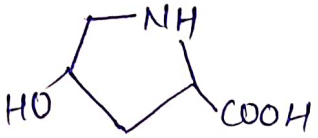
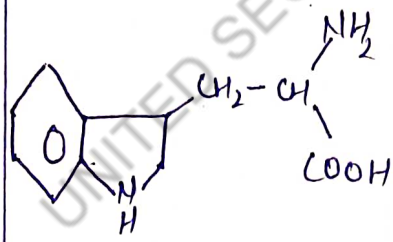
* All amino- acids contain at least one amino group. and at least one carboxyl group in the molecule. Both the amino group & carboxyl group are attached to the same carbon atom, to which another organic residue is attached. The general structure is :—



* As the amino group is attached to the carbon alpha to the carboxyl group, these are also known as α- amino acids.
* Organic acids may have an amino group anywhere in the molecule and called amino acids.

No.	Name	Structure	Chemical Name.	Abbreviated Name.
1.	Glycine	NH_2-CH_2-COOH	2- Amino-acetic acid	Gly.
2.	L- Alanine	$CH_3-CH(NH_2)-COOH$	L- 2-Amino-propionin acid	Ala.
3.	L- Valine	$(CH_3)_2CH-CH(NH_2)-COOH$	L-2-Amino-isovaleric acid	Val.

(6)	L-Isoleucine		L-2-amino-3-methyl-valeric acid	(3) Ileu.
(6)	L-Serine		L-2-Amino-3-hydroxy-propionic acid	Ser.
(7)	L-Threonine		L-2-Amino-3-hydroxy-butyric acid	Thr.
(8)	L-Cysteine		L-2-Amino-mercaptopropionic acid	cys.
(9)	L-Cystine			Cys-SS-Cys
(10)	L-Methionine		L-2-Amino-4-methyl-thiobutyric acid	Met.
(11)	L-Aspartic acid		L-2-Amino-succinic acid	Asp.
(12)	L-Glutamic acid		L-2-Amino-glutaric acid	Glu.
(14)	L-Arginine			Arg.
(15)	L-Phenyl-alanine		L-2-Amino-3-phenyl propionic acid	Phe.

(16)	L-Tyrosine		L-2-Amino-3-(4-hydroxyphenyl)-Propionic Acid	Tyr
(17)	L-Histidine		L-2-Amino-3-(5-imidazolyl)-propionic acid	His.
(18)	L-Proline		L-Pyrrolidine-2-carboxylic acid	Pro.
(19)	L-Hydroxyproline		L-Pyrrolidine-4-hydroxy-2-carboxylic acid	Hypro.
(20)	L-Tryptophan		L-2-Amino-3-(3'-indolyl)-Propionic acid	Trp.

Classification of Amino-Acids

Aliphatic Amino Acids (no ring system)

1) Mono-amino-monocarboxylic acid
   eg- glycine, alanine, valine.
2) Hydroxy-mono-amino-monocarboxylic acids.
   eg:- serine, threonine.
3) Sulphur containing amino-acids.
   eg:- cystein, cystine
4) Mono-amino dicarboxylic acids.
   eg:- aspartic, glutamic
5) Basic amino-acids
   eg:- lysine, arginine.
6) Amido amino-acids
   eg:- asparagine & glutamine.

Aromatic & Heterocyclic Amino Acids.

1) Aromatic Amino-Acids
   eg- Phenylalanine
2) Heterocyclic Amino-Acids
   eg- Proline, Hydroxyproline, Histidine, tryptophan.

Properties of Amino Acid :-

A) Physical properties:-

1) Solubility:-

* All amino acids are soluble in water but their solubility varies to a great extent.
* solubility depends on the nature of R-group. i.e., polarity of the amino acid.

* Polar amino acids are highly soluble in water.
* Non-polar amino acids are highly soluble in organic solvents like chloroform, ether etc.

2) Acid and base behaviours :-

* Amino acids contain the acidic carboxyl group (-COOH) & the basic group amino (-NH_2). Hence acids are called as amphotenic molecules or ampholytes (i.e., Amphoteric electrolytes).

3) Optical activity :-

* All standard amino acid except glycine has an asymmetric carbon atom due to these amino acids are optically active.

B. Chemical Properties -

1) Ninhydrin reaction :-

Amino acid + Ninhydrin ⟶ Purple / Blue pigment + Aldehyde.

2) Reaction with Dansyl chloride :-

Amino acid + Dansyl chloride ⟶ Fluorescent Dansyl derivative of amino acids.

3) Reaction due to COOH group :-

* Salt formation with alkalis.
* Ester formation with alcohol.
* Amide formation with Amines & decarboxylation.

Structure of Protein :-

(A) Primary structure :- The exact sequence of amino acids in each chain of a single protein molecule is termed the primary structure. The determination of the primary structure of protein involves the following stages :-

1. Purification
2. Hydrolysis
3. separation, isolation & identification.
4. quantitative estimation
5. sequence
6. Determining the number of chain in the molecule.
7. Determining the nature and position of bridge

(1) Purification :- This may be achieved by
* Precipitation with salt or alcohol.
* Ion exchange chromatography.
* gel filtration.
* electrophoresis.
* electrophoresis.

(2) Hydrolysis :- This may be achieved by acid, alkaline and enzymic hydrolysis.

(3) separation, isolation & identification :- The mixture of amino acids can be separated by paper chromatography or TLC and detected

by spraying with -of ninhydrin Reagent.

④ Qualitative determination:- qualitative estmation of the amino-acids will be necessary to determine their relative proportions.

⑤ Sequences:- Sequence of amino-acids starting from the amino-acid (N-terminal amino acid) to the hydroxyl end of the chain (C-terminal amino acid). This is usually achieved by step by step cleavage of the peptide chain by enzymes like amino-polypeptidase, which starts cleavage from N-terminal amino-acid or by carboxy-polypeptidase, which starts cleavage from C-terminal amino ~~acid or by carboxy-polypeptidase~~.

* The degradation can be repeated step by step, as each time only the N-terminal amino acid is cleaved.

⑥ Determining the number of chain in the molecule:- This is easily determined by finding out the number of N-terminal amino-acids or C-terminal amino acids.

⑦ Determining the nature & position of Bridge

(B) Secondary Structure:- Secondary structure forms by the interaction between the polypeptide chain of primary protein amino group & carboxyl group. It mainly presents two structural forms —

> α- Secondary protein (Helix form).
> β secondary protein (sheet/plate form).

(c) Tertiary protein:- Tertiary protein form by the further chemical modification between the secondary protein. It is stabilized due to presence of the H- bond, electrostatic forces, disulphide bonds and Vander walls forces.

(d) Quaternary protein:- The quaternary structure of a protein is the association of several protein chain or subunits into a closely packed arrangement.

Qualitative tests for proteins & Amino Acids.

(1) Heat test:- When protein sol^n is heated in boiling water both the protein gets coagulated and lose their biological activity.

* This is called thermal denaturation of protein

eg:- Boiling the eggs.

(2) Test with trichloroacetic acid (TCA) - TCA is normally used to precipitate proteins from their solution. TCA denatures the proteins.

(3) Biuret Test - Biuret reagents consists of copper sulphat

in an alkaline medium when proteins are treated with Biuret reagent it's shows a violet colour.

④ Hydrolysis test – Proteins on hydrolysis gives free amino acids. Hydrolysis can be carried out by acids like HCl, H_2SO_4 etc. or Alkalis NaOH, KOH etc.

⑤ Xanthoprotein test – Nitration of aromatic amino acids of protein give yellow colour. concentrated Nitric acid is used for Nitration.

⑥ Million's Test – Phenolic group of tyrosine of protein react with mercuric sulphate in the presence of Sodium Nitrate and sulphuric acid to give red colour.

Biological Role of Proteins & Amino Acids

* Proteins give amino acids on hydrolysis during digestion & amino acids are the building Blocks required for a cell to synthesis for proteins.
* Proteins are the structural component of protoplasm cell & tissues.
* Enzymes & few hormones are proteins in nature antibiotics, haemoglobin are also proteins.
* Protein is one of the important components of diet it is required to maintain growth and

healthy functioning of the body.

* In the cell, cell membrane is also made up by the protein, protein play the role in the transporting the cellular & outer material through the active & passive transport.

Diseases Related to malnutrition of Protein

(1) Kwashiorkor :-

* The symptoms of the diseases slow down the growth, oedema & change in skin, hair pigmentation & texture.
* Frequently there is liver enlargement there is vomiting & diarrhoea & stools contain much undigested food.
* The course of this disease due to large family size, poor mental health, poor environmental conditions & delayed supplementary feeding.

Note - This disease appears most commonly in children between the ages of 1 to 4 years.

(2) Nutritional oedema :-

* It results from long contained loss of protein & usually occurs in famine areas. The protein

deficiency in adults is very rare.

* The deficiency symptoms include loss of weight, infections, frequent loose stools & oedema.
* Use of soybean, milk and eggs and other nutritious diet can cure the protein deficiency syndrome in adults.

③ Marasmus :-

* It is a disease of infants below one year of age.
* Its cause is proteins & carbohydrate or other nutritional factor deficiency.
- Proteins and energy deficiency disease is also known as Marasmus kwashiorkor.
- Marasmus is more likely to occur in poor people.