Amino Acids & Proteins

Proteins → Most abundant organic molecule present in the body of living organism.

Composition:- Hydrogen, carbon, oxygen, Nitrogen & sometimes ~~sulfer~~ sulfer.

structural unit:- Proteins are made up of small units called Amino Acid. They are polymers of amino acids arranged in the form of polypeptide chains.

Amino Acid:- It is an organic molecule having an amino group ($-NH_2$) and a carboxyl group ($-COOH$).

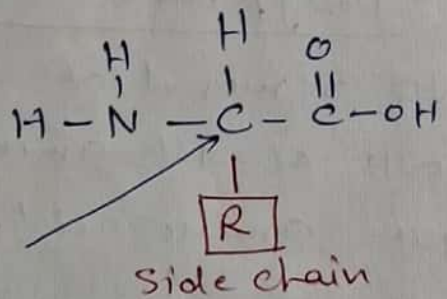
Amino Acid (Monomers)

- Amino → $-NH_2$ (Amino group)
- Acid → $-COOH$ (carboxyl group) Acidic

Amino acids is

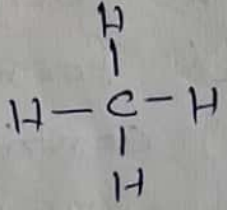
⇒ substituted Methanes

⇒ Basic unit to form proteins



α-Carbon ↓ attached with 4 different groups

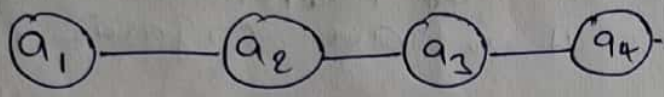
Side chain (variable group)

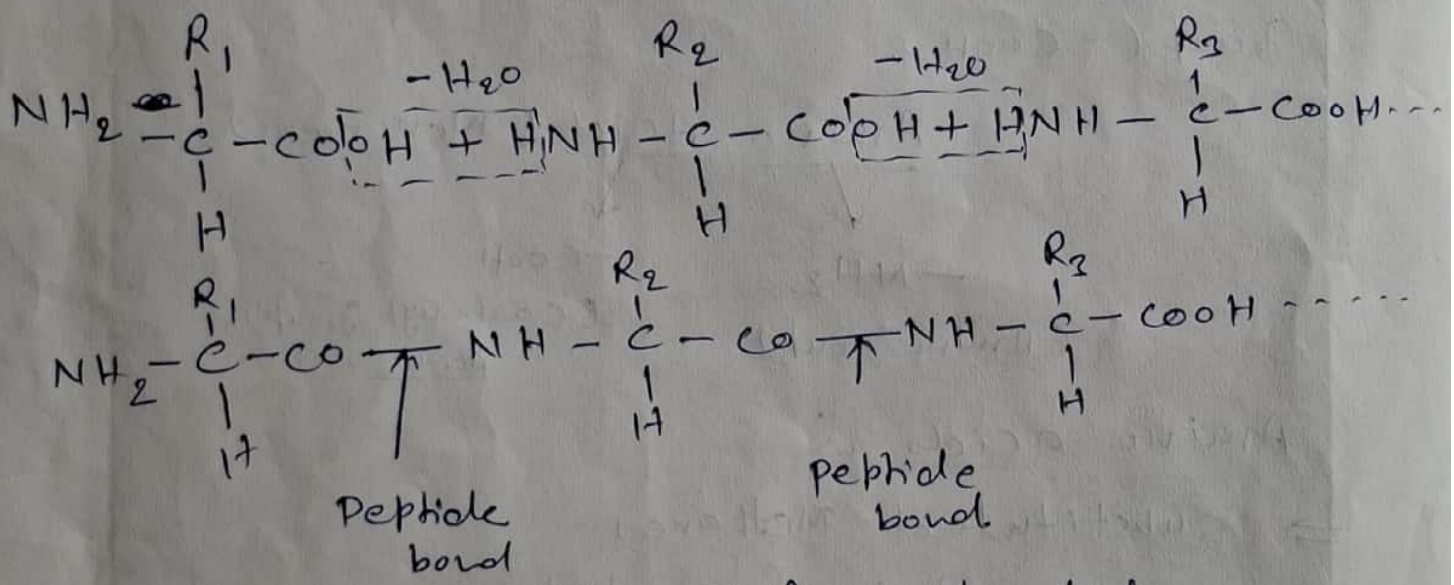


(2) 300-400 amino acids are found in living organism but 20-22 amino acids are take part in protein synthesis.

Polypeptide Bond (Chain) Formation:-

Amino acids are added and form Proteins. Proteins are Hetropolymers. Let- $a_1, a_2, a_3 \ldots\ldots$ are amino acids.





Peptide bonds are formed between amino acids called Polypeptide Chain. It is formed by the removal of H_2O. ($-OH$) contributed by COOH of 1st amino acid & ($-H$) by NH_2 of next amino acid.

These are condensation reaction or dehydration reaction.

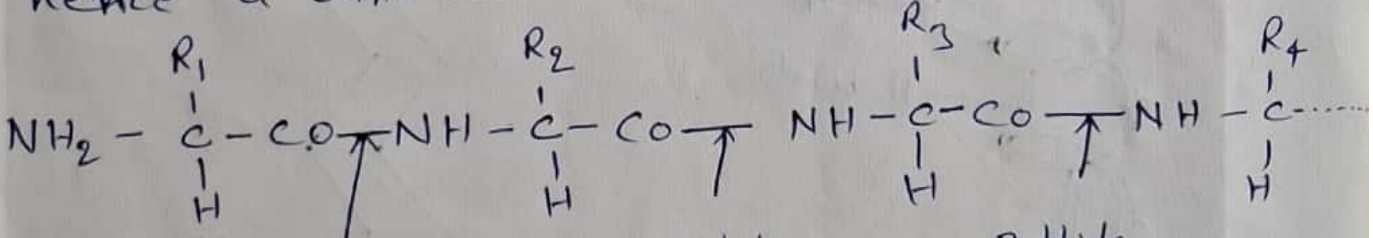
Structure of Proteins

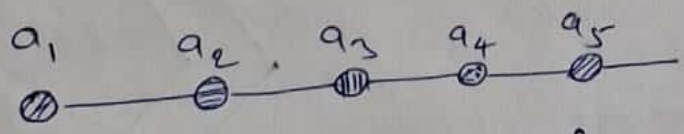
Structure of proteins is classified at 4 levels:-

Classification of Proteins
on the basis of structure

- Primary Structure
- Secondary structure
- Tertiary structure
- Quaternary structure

1) Primary :- It is a linear arrangement of amino acids. (Found in immature proteins-Ribosome) changing the position of even a single amino acid will result in a different chain and hence a different protein.





P. structure gives us information about

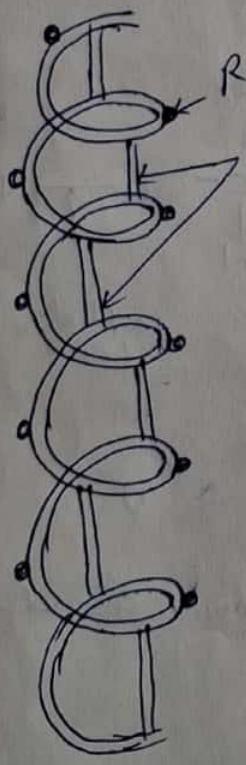
i) No. of amino acid
ii) Arrangement of amino acid
iii)

2) **Secondary** :- The secondary structure of a protein is formed by hydrogen bonding in the polypeptide chain.

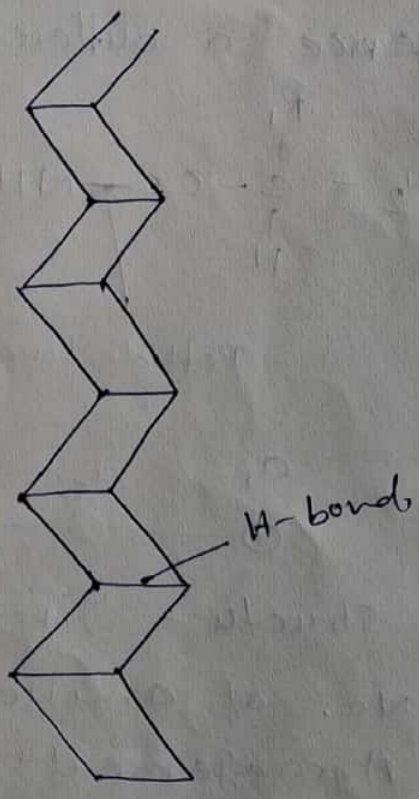
These bonds cause the chain to fold and coil in two different way :- α-helix or β-pleated sheets.

α-helix :- α-helix is like a single spiral and is formed by hydrogen bonding between every fourth amino acid.

β-pleated sheet :- β-pleated sheet is formed by hydrogen bonding between two or more adjacent polypeptide chains.



α-helix



β-sheet

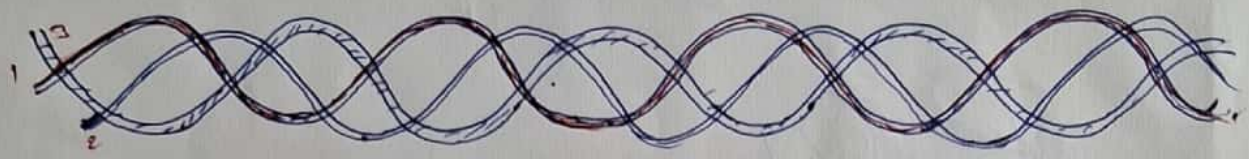
Ex:- α-helix → Keratin (hair + nails)

β-sheet → Fibroin (silk protein)

Fibrous protein → Collagen (present in connective tissues)

Structure of Collagen

3 helices ⊥ar to each oth.



3) Tertiary :- Three-dimensional folding of a single polypeptide chain, gives tertiary structure.

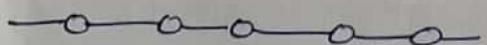
This level of structure creates specific sites (or pocket) for biological activity, like active sites in enzymes or binding sites for substrates.

Ex:- Myoglobin (Tertiary str.) → Allow it to bind oxygen molecules efficiently.

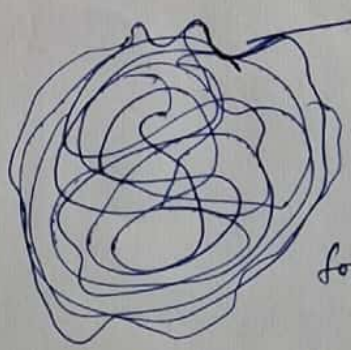
Enzymes → increase rate of reaction

↓

Digestion, Blood clotting, Growth, muscle function, Manufacturing (wine, bread, cheese etc)



single polypeptide chain



↓

very important for Biological activity

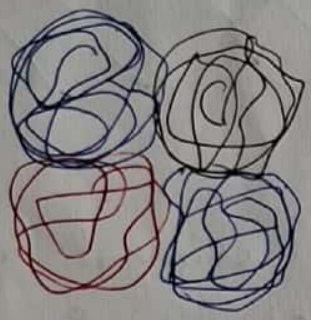
↓

Enzymatic activity + interaction with other molecules.

4) Quaternary structure :- This structure is formed only by those protein which have multiple polypeptide chains combined to form a large complex.

The individual chains are called subunits. Ex:- Heamoglobin (globular protein), insulin

2α 2β



← Quaternary structure

Classification of proteins

on the basis of composition

Simple

only amino acids form their structure.

$a_1 - a_2 - a_3 - a_4 \cdots$

Ex- Pepsin, Trypsin

Conjugated.

consisting of globular protein and highly bound prosthetic group.

Attachment

[i.e Additional group also added]

Example of conjugated proteins :-

Name	Prosthetic group	Occurrence
i) Phosphoprotein	Phosphoric acid	→ Casein of milk, Vitellin of egg Yolk
ii) Glycoprotein	Carbohydrate	→ Membrane structure, Mucin (component of saliva)
iii) Nucleoprotein	Nucleic acid	→ Component of virus, Chromosomes, Ribosone structure

[Globular protein- A globular protein is a protein that is spherical or globe-like in shape and is soluble in water.

(4)

Classification of Proteins

on the basis of production in body

Essential

⇒ Not produced by body

⇒ Essential to be taken in diet (Pulses)

Ex: Lysine

Non-Essential

⇒ Produced by body

⇒ Not essential to be taken in diet

Ex- Glycine, serine

semi-essential

⇒ Produced at very slow rate

⇒ so partially eaten

Example → Arginine

structure based function of Protein :-

Proteins are like tiny machines inside our bodies, and their shapes determine what they do. some function of proteins are :-

1) **Enzymes** :- Proteins that speed up chemical reactions have active sites formed by the specific tertiary and sometimes quaternary structure of the protein, is called Enzymes. Ex- Pepsin and trypsin are the enzymes that- help in digestion of proteins.

2) **Cellular communication** :- Through receptors on their surface, cells can communicate with other cells and the outside world. These receptors are made of proteins. (Ex- Hormone) (Insulin)
Ex- cell surface receptor proteins

3) **Transport Proteins** :- These proteins help to move substance across cell membranes. Their structures create channels or carriers that allow specific molecules to pass through.
Ex:- Channel proteins, gated Channel proteins & carrier proteins

4) **structural Proteins** :- Proteins like collagen (triple helix structure) or Keratin (α-helix structure) provide support and strength to cell and tissues. Their structures make them strong and flexible.
Keratin found in hair & nails of humen & animals.
collagen present- in connective tissues.

5.) Respiration :- ~~Heamo~~ Hemoglobin formed by quaternary structure, transports O_2 in blood.

6.) Immune Response :- Antibodies have a quaternary structure which fights against infection. Ex:- Immunoglobulin

Function of Proteins :-

1) **Building and repairing cells :-** Proteins are the building blocks of life and are required for the body to repair and make new cells.

2) **Maintaining structure and function :-** Proteins are responsible for the structure, function and regulation of the body's tissues and organs.

3) **Making hormones and enzymes :-** The body uses amino acids to make hormones and enzymes, which control physiological process like growth, development and metabolism.

4) **Maintaining pH balance :-** Proteins help maintain the proper pH balance in the blood, which is slightly basic and range from 7.35 to 7.45.

5) **Providing Energy :-** Proteins can be used as an energy source.

6) **Helping with fitness :-** Eating protein can help with fitness by speeding up recovery after exercise, reducing muscle loss and building lean muscle.

Engineering Applications of Proteins :-

1) **Making Better Medicine :-** Scientists use proteins to create drugs that can treat diseases like diabetes & cancer.

2) **Cleaning up the Environment :-** Proteins can be used to break down harmful chemicals in a cleaner and more eco-friendly way.

3) **Creating safer Food and Drink :-** Enzymes, a type of protein are used to make food and drinks safer and tastier.

4) **Building Tiny Machines (Nanotechnology) :-**

Proteins are like tiny machines that can be engineered to do specific tasks, like delivering medicine to exact parts of the body.

[Proteins are utilized as building blocks for constructing nanostructures and devices. Protein-based nanoparticles are used in drug delivery to exact parts of the body.]