Proteins

Proteins are the primary constituents of all living matter as they are found in all living cells. They are the most abundant organic molecules in animals. Proteins perform several important biological functions.

1.) Proteins serve as structural material
2) Proteins act as enzymes
3) Few proteins function as hormones
4) Proteins are responsible for many physiological functions
5) Protective proteins act as antibodies giving protection against a disease.
6) Proteins are also associated with hereditary characters
7) Cell secretions like mucus are glycoproteins
8) Spiders and silkworm secret a thick solution of protein fibroin, which solidifies into thread of high tensile strength and is used for weaving web or cocoon. We get silk from the cocoon.
9) Proteins are stored as reserve food.

Classification of Proteins on the basis of their shape

1) Fibrous Proteins 2) Globular Proteins

1) Fibrous Proteins:-

They are tough and usually insoluble in water and aqueous solutions of acids and bases. Fibrous protiens have long and thread like structure and tend to lie side by side to form fibres. Fibrous proteins serve as the chief structural material of animal tissues

a) Keratins: α- keratins are found in outer layer of skin, in hair and wool. They consist of α- helices that are twisted together like the strands of a rope.

β- Keratins are found in hard tissues such as nails, horns, hooves and bird feathers. They have β- pleated sheet structure

② Collagens:- Collagens proteins are found in white fibrous connective tissue, which consitute tendons. These are also main Components of bone, teeth and cartilage.

③ Elastins:- They are found in yellow elastin tissue like ligaments and blood.

④ Fibroin:- This protein is present in Silk fibres.

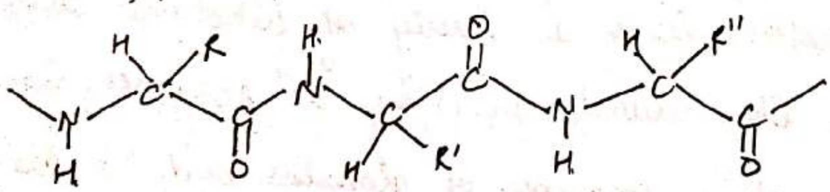
Globular Proteins:-

Globular proteins are soluble in water or aqueous Solutions of acid bases or Salts. These Solutions are Colloidal in nature due to the large size of protein molecules. Globular proteins are folded into roughly spherical shapes.
Globular proteins Serve a variety of functions that require mobility, they usually function as enzymes, hormones or transport proteins. Example of globular proteins are insulin, haemoglobin, ribonuclease and fibrinogen, which is converted into the insoluble fibrous protein, fibrin and causes the Clotting of blood.

Structure of Proteins

Primary structure :-

The primary structure of a protein refers to linear sequence of amino acids in its polypeptide chain and location of disulfide bridges, if any. It represents the number, nature and sequence of amino acid molecules in the polypetide chain. All the properties of a protein molecule are determined, directly or indirectly, by primary structure. Any folding or Catalytic activity of the protein molecule depends on the proper primary structure. In primary structure the peptide bonds form the backbone and the side chain of amino acid project outside the peptide backbone.



Secondary structure :-

The folding of linear polypeptide chain into specific arrangement, represents Secondary structure of protein molecules. It results by hydrogen bonding between N-H & C=O groups of amino acid of the peptide chain. These bond can occur either with in the molecules of the polypeptide chain forming α-helix or between different polypeptide chains of protein to form pleated sheet.

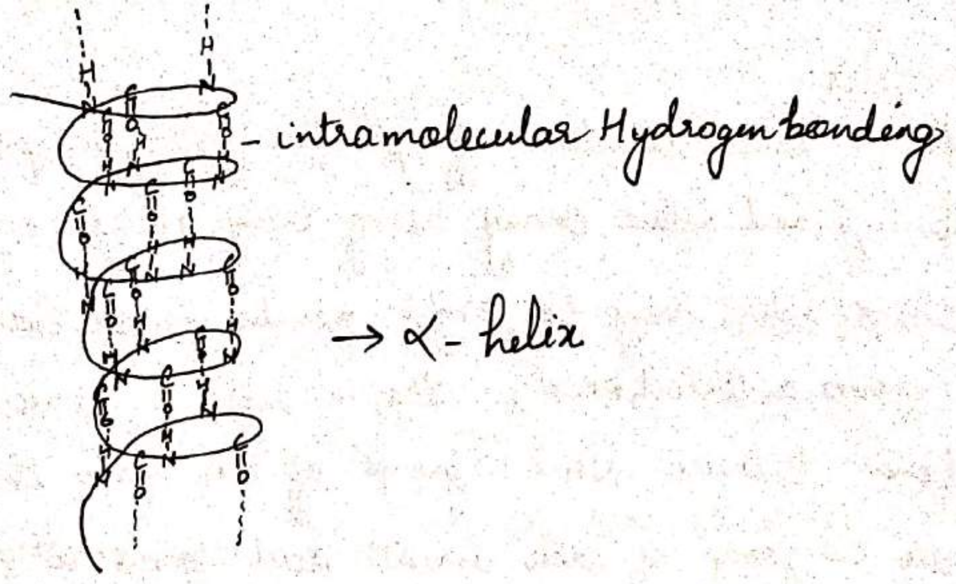
α- Helix:-

The α-helix structure of proteins was first proposed by Linus Pauling and Robert Corey using X-ray analysis of proteins.

The α-helix may be right handed (moves clockwise) or left handed (moves anticlockwise). The α-helix is stabilised by hydrogen bonds between NH & CO groups of the main chain. In particular the CO group of each amino acid forms a hydrogen bond with the NH group of amino acid that is situated four residue ahead in sequence. In α-helix conformation, the polypeptide chain assumes the form of a spiral staircase with 3.6 amino acid residues perturn helix. The coils of the helix are held together by hydrogen bonds lying parallel to the main axis and all side chains extend outward from the axis of spiral. Such a structure is attributed to a series of regularly spaced hydrogen bonds and van der Waals forces between atoms in the main chains.

The α-helices of almost all natural proteins are right handed. The right handed α-helix is more stable than left handed α-helix. In left handed α-helix, steric hinderance is observed between carbonyl group and the side chain of amino acid residues causing reduced stability.

α-helix is the predominant structure of the polypeptide chains of fibrous proteins such as myosin, the protein of muscles and of α-keratin, the protein of hair, unstretched wools and nails.



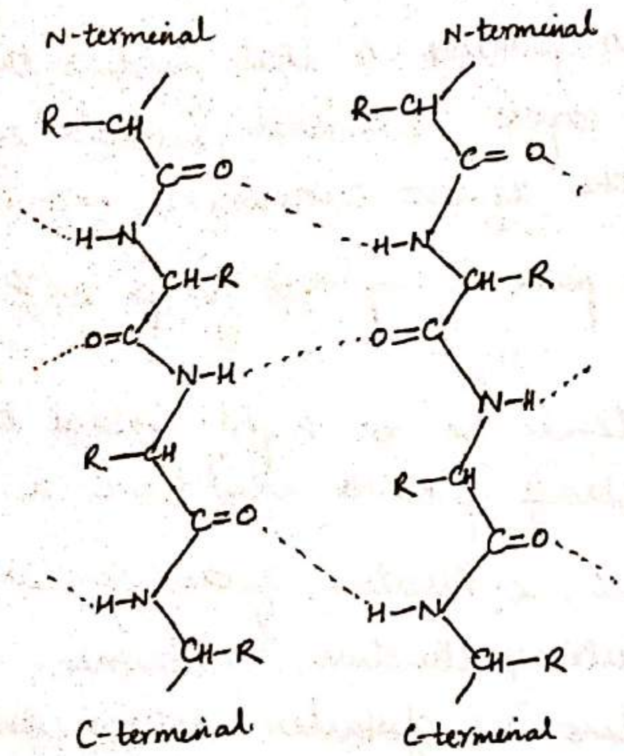
The β-Pleated Sheet:-

The second type Secondary structure is the β-pleated sheet. The β-pleated sheet differs from α-helix. It is Composed of two or more polypeptide chains called β-strands. A β-strand is almost fully extended rather than being coiled as in α-helix. In a β-pleated Sheet structure hydrogen bonding occurs between two or more peptide chains and these bonds are at right angles to main chain. In this arrangement each Carboxyl oxygen on one chain forms a hydrogen bond with the N-H hydrogen on adjacent chain. The adjacent hydrogen bonded peptide chains can run in the Same direction (parallel β-pleated sheet) or in opposite direction (antiparallel β-pleated sheet). In either case, side chains are on opposite sides of sheet.

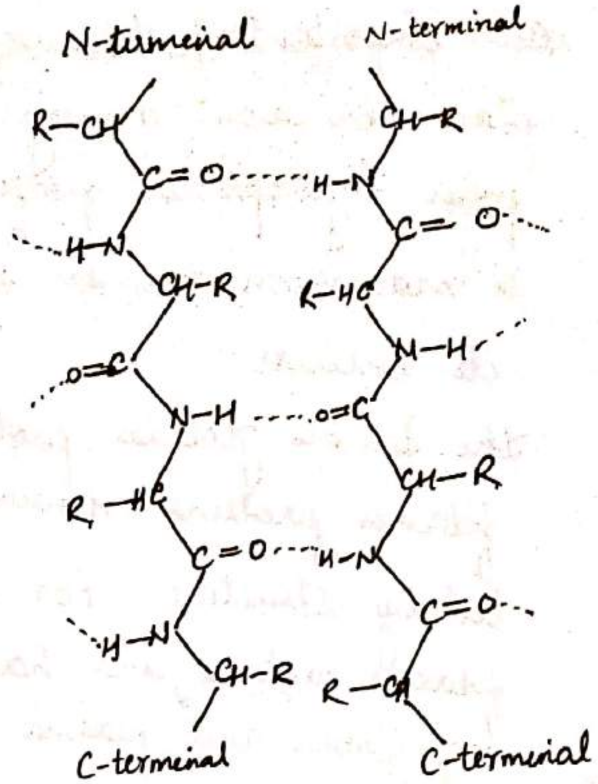
Silk has large segments of β-pleated sheets because it has a large number of small amino acids

β-keratin found in feathers and Claws is another example

Fibres containing β-pleated structures are not elastic because the polypeptide chains are fully extended.



Parallel



Antiparallel

Tertiary structure :-

The tertiary structure of a protein is the final three-dimensional shape that arises due to further folding of its polypeptide chain. These foldings do not occur randomly. Proteins fold in Solution in order to maximise their stability. They occur in a particular way, a way that is Characteristic of a particular protein. The major stabilizing force responsible for compact three-dimensional (3D) form of tertiary structure is hydrophobic interactions between non-polar Side chains of amino acids. Beside this the polar Side chains undergo hydrogen bond formation and ionic interactions. (The stabilising interactions that occur in folding are Covalent bonds, hydrogen bonds, electrostatic attractions and van der waals or hydrophobic interactions.) So, a protein tend to fold in a way that maximizes the number of Stabilizing interactions. Disulfide bonds are the only covalent bonds that can form when a protein molecule folds.

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An important feature of most proteins is that folding takes place in such a way as to expose maximum number of polar hydrophillic groups to the aqueous enviroment and enclose a maximum number of non-polar hydrophobic groups with in its interior.

The soluble globular proteins tends to be highly folded than fibrous proteins. However fibrous proteins also have a tertiary structure. For example, α-keratin, fibrinogen are fibrous proteins and have tertiary structure. Albumein, myoglobin and plasma globulins are globular proteins possessing tertiary structure.

Quaternary Structure:-

The quaternary structure involves the non-covalent association of two or more polypeptide chains in the protein molecule. Proteins that have more than one peptide chain are called Oligomers. The individual chains are called subunits. In quaternary structure, these subunits are held together by the same kinds of interactions that hold the individual protein chains in a particular three dimensional conformation. They are hydrophobic interactions, hydrogen bonding and electrostatic interactions. The quaternary structure of a protein describes the way the subunits are arranged in space.

Ex- Haemoglobin consists of four peptide chains fitted together to form a globular proteins