PROTEINS-Structural levels of the organization

Dr. Sugandha Tiwari
Associate Professor
Dept. Of Botany
Dayanand Girls' P.G. College, Kanpur
sugandhatiwari7@gmail.com

Learning outcomes

Structural levels of the organization of proteins

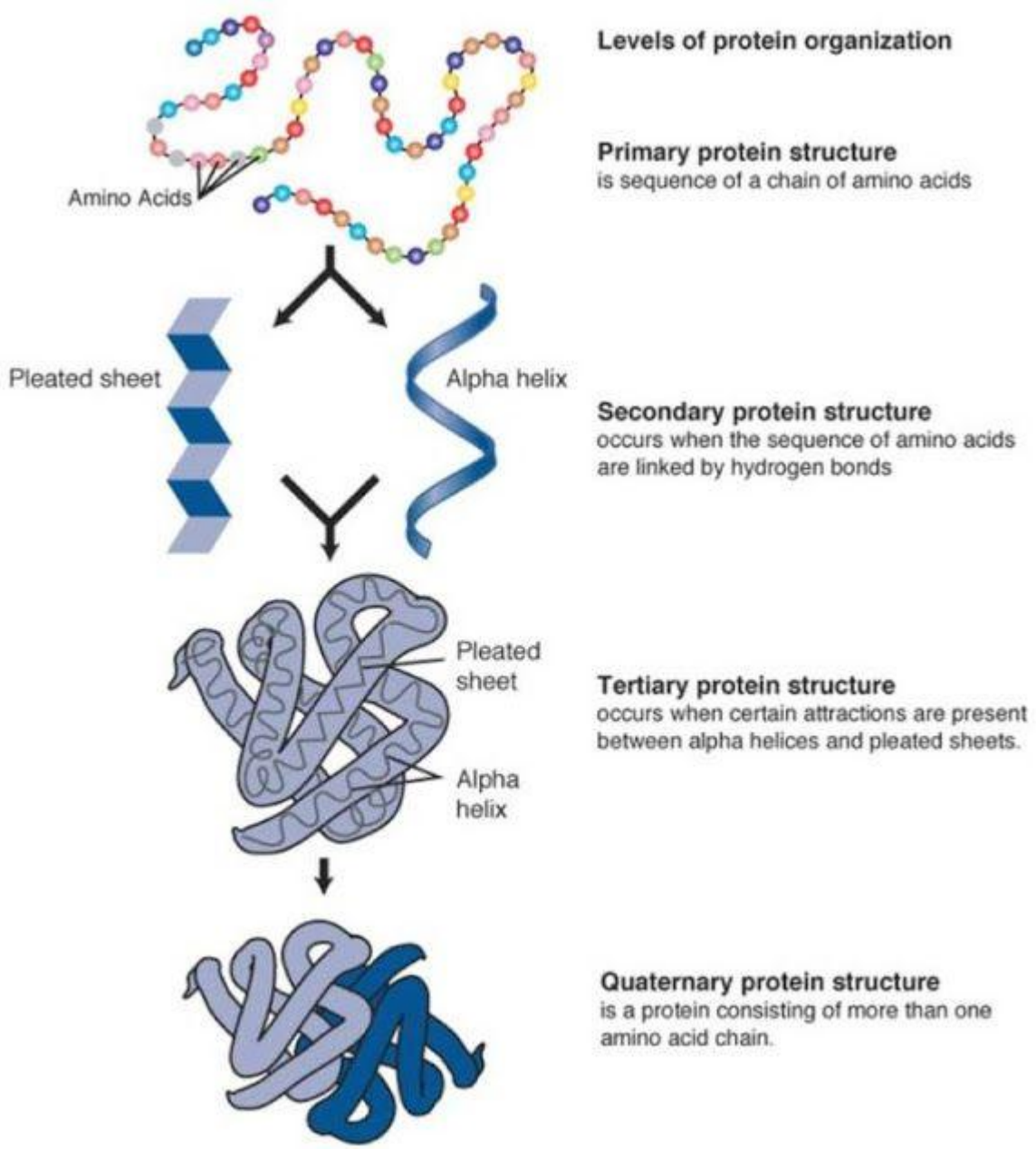
- Primary structure
- Secondary structure
- Tertiary structure, and
- Quaternary Structure of Proteins

Denaturation of proteins

Structural levels of the organization of Proteins

Four basic structural levels of the organization of proteins are:

- Primary 1°
- Secondary 2°
- Tertiary 3° and
- Quaternary 4°



Levels of protein organization

Primary protein structure
is sequence of a chain of amino acids

Secondary protein structure
occurs when the sequence of amino acids are linked by hydrogen bonds

Tertiary protein structure
occurs when certain attractions are present between alpha helices and pleated sheets.

Quaternary protein structure
is a protein consisting of more than one amino acid chain.

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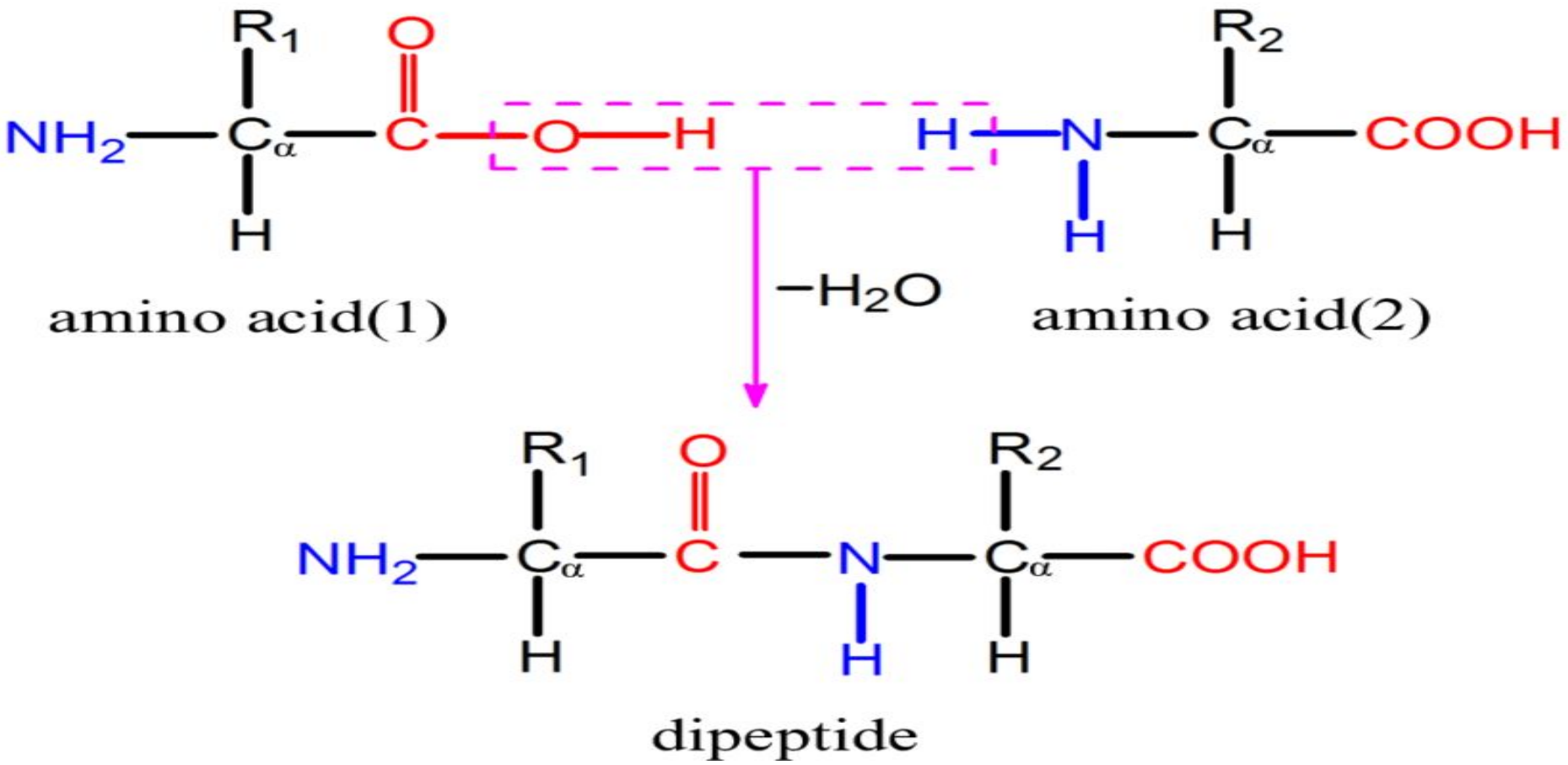
Primary structure of Protein

The primary structure of a protein refers to the number and sequence of amino acids.

Amino acids in proteins are linked with the peptide bond (covalent bond) which links the α carboxyl group of one amino acid residue to the α-amino group of others.

The proteins may consist of one or more peptide chains.



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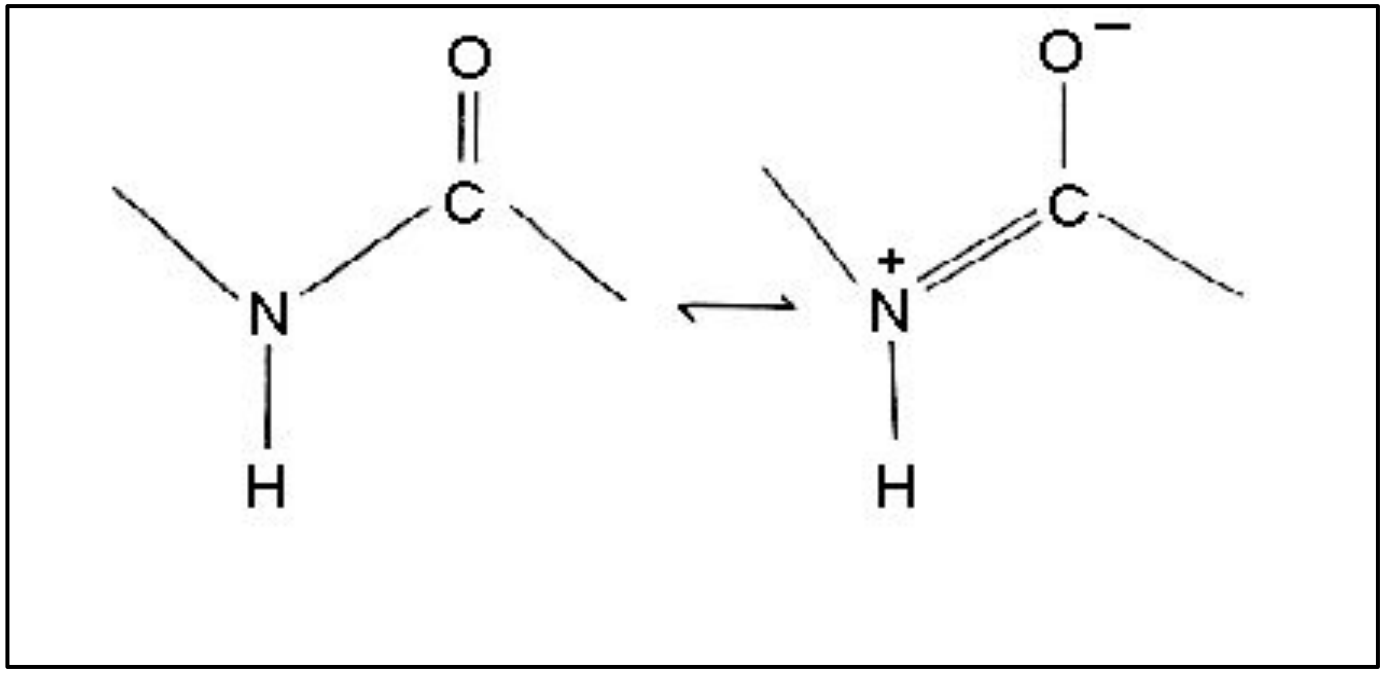

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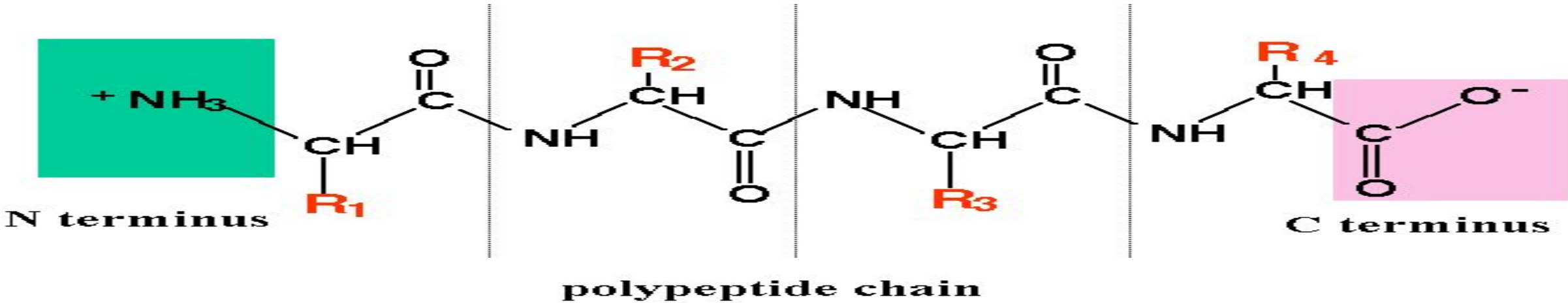
Peptide bond has partial double bond character. It is rigid and planar and O and H are trans in position

Peptide = chain of amino acids



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Protein secondary structure

The most prominent secondary structure are:

- Alpha helix and
- Beta confirmations
- Loops

Alpha Helix

Alpha helix is right-handed.

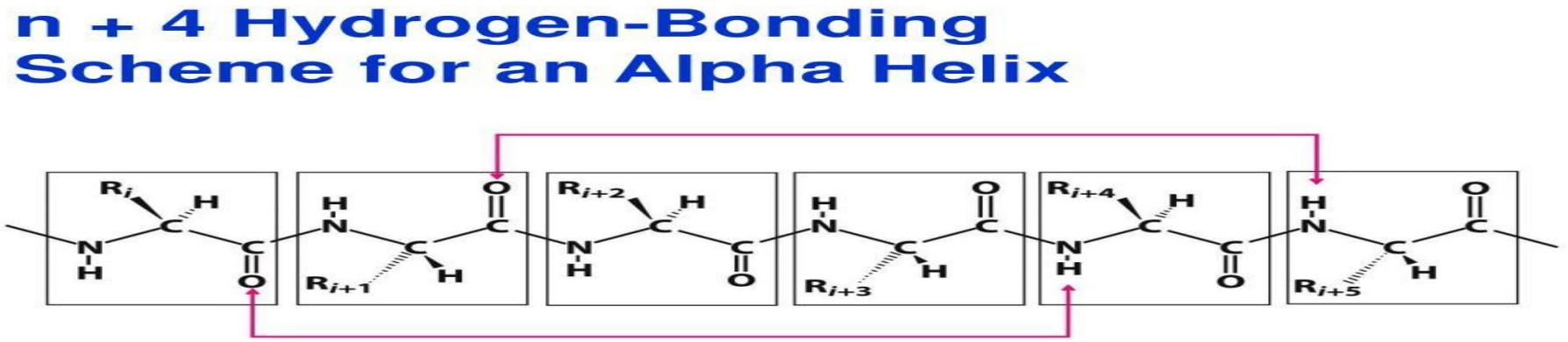
Peptide bonds are parallel to the long axis of the helix and the R groups of the amino acid Residues protrude outward from the helical backbone.

The repeating unit is a **single turn of the Helix**, which extends about 5.4 angstroms along the long axis.

Each helical turn includes 3.6 amino acid residues.

Alpha Helix

The structure is stabilized by hydrogen bonds between the electropositive nitrogen atom of a peptide linkage and the electronegative carbonyl oxygen atom of the fourth amino acid on the amino-terminal side of the peptide bond.



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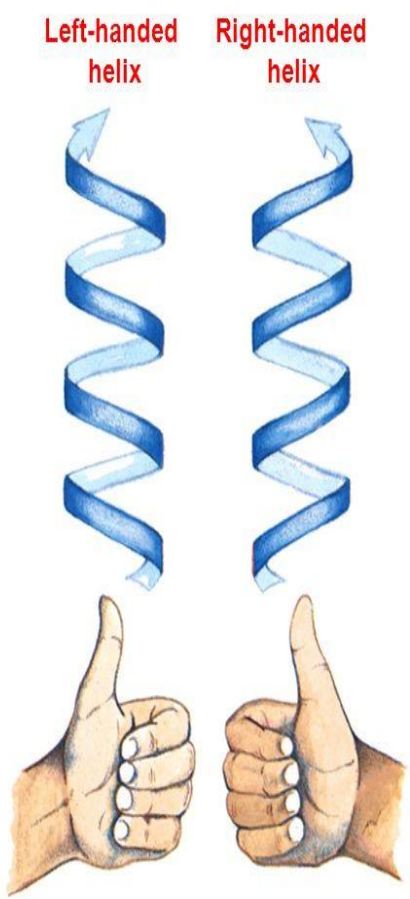

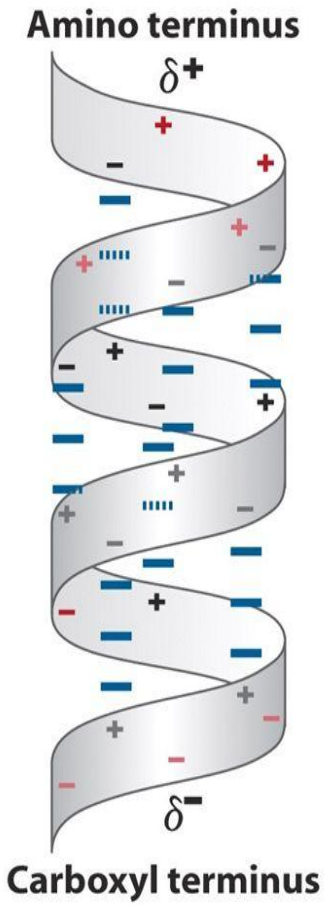

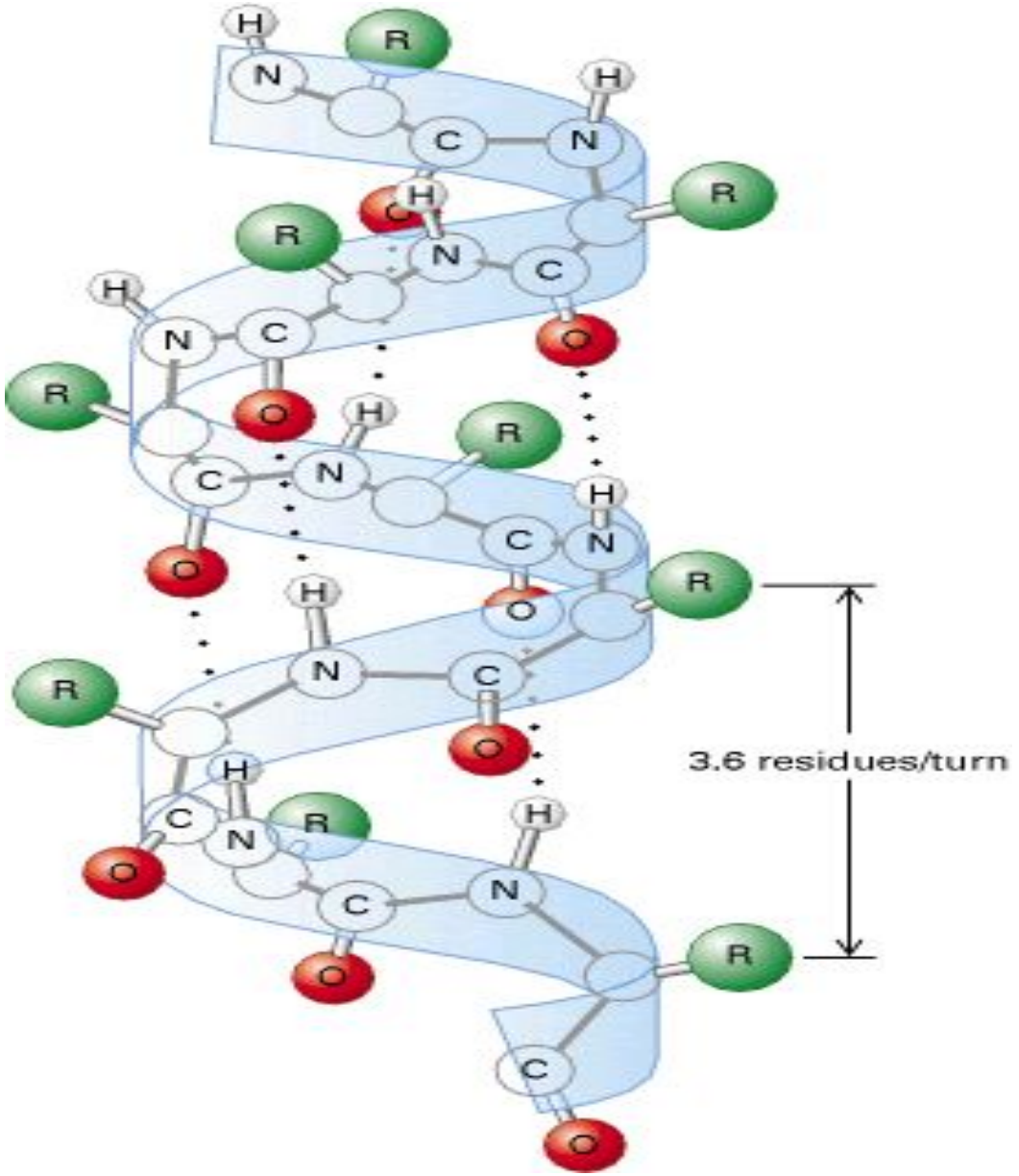

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https://www.researchgate.net/profile/Larbi_Filali2/publication/324706585/figure/fig26/AS:618708808499220@1524523083724/a-helix-structure-6.png

Beta conformation

The polypeptide chain is extended into a zigzag arrangement.

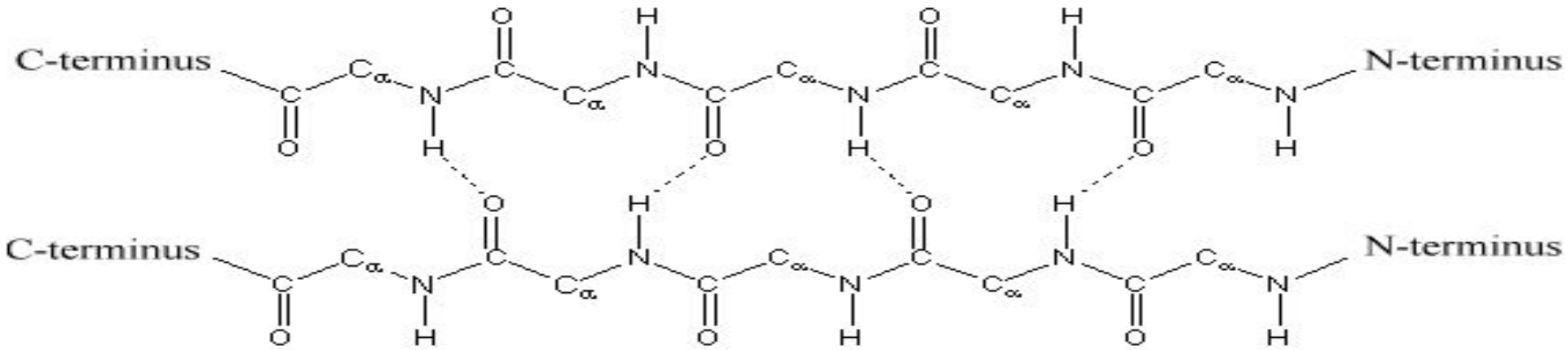
Polypepetide chains are arranged side by side in the form of pleats/ sheets.

Hydrogen bonds are formed between adjacent segments of polypeptide chains.

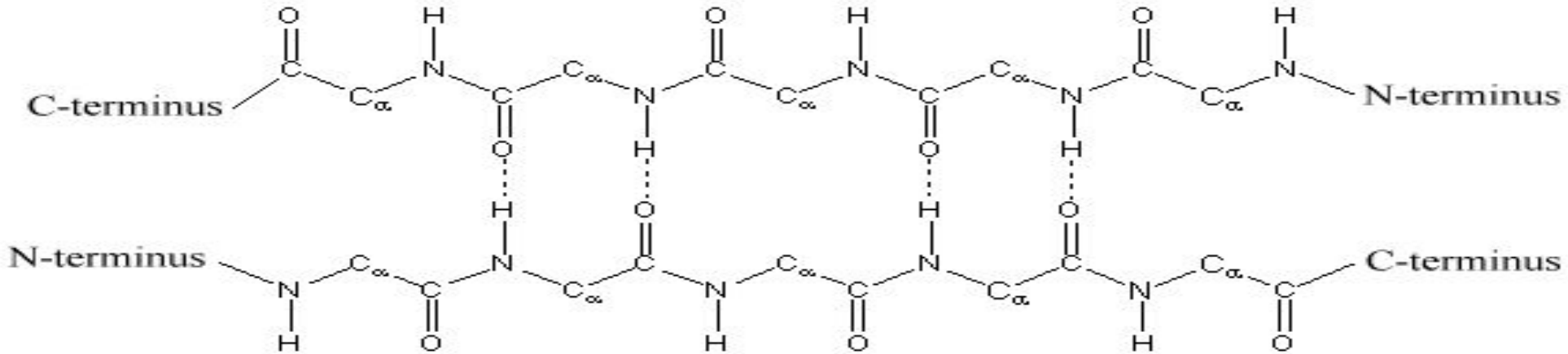
The R groups of adjacent amino acids protrude in opposite directions.

The adjacent chains can be parallel or antiparallel.

Parallel β Sheet



Antiparallel β Sheet



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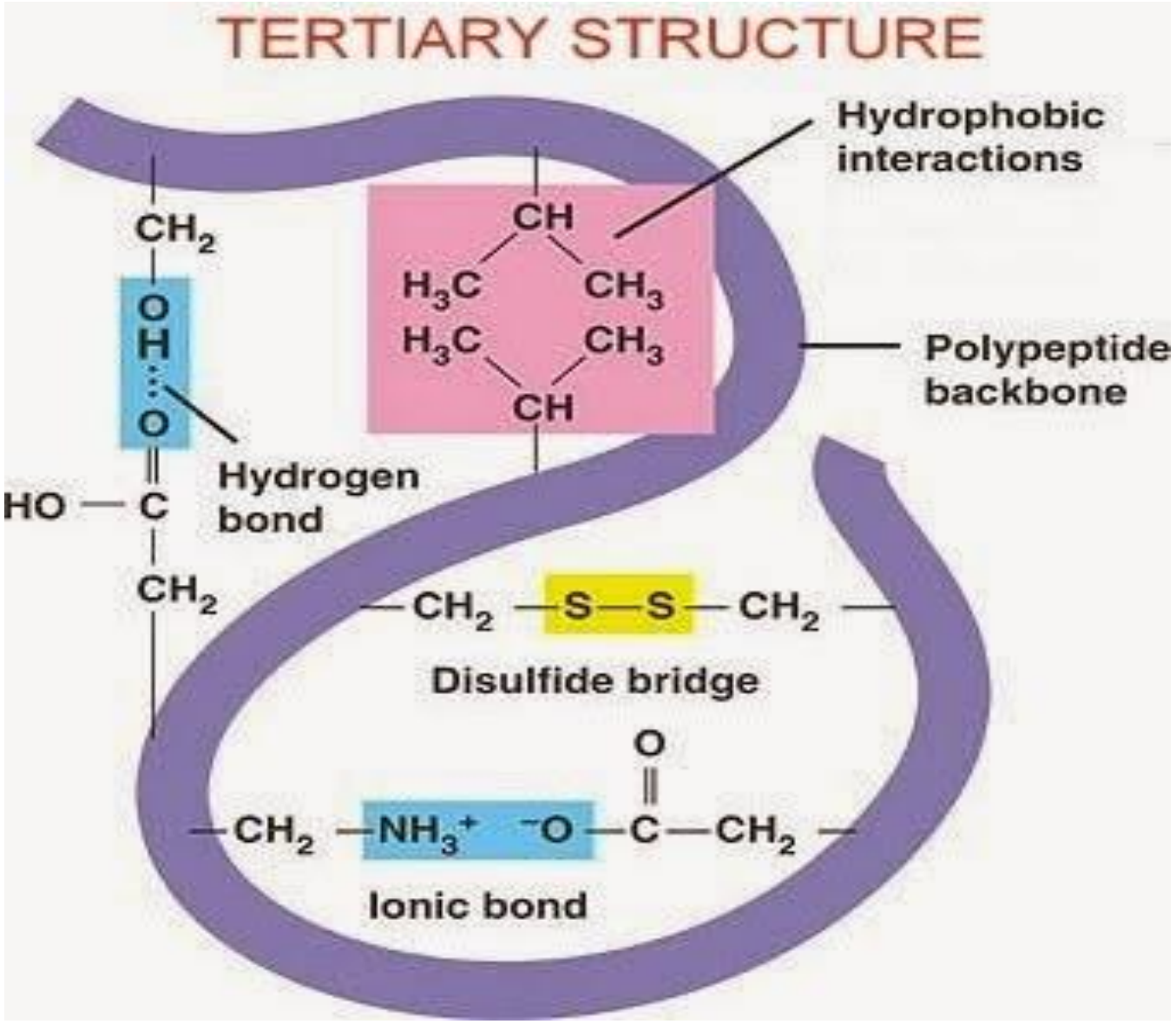
Tertiary Structure of a Protein

The overall three-dimensional arrangement of all atoms in a protein is referred to as the protein's tertiary structure.

Disulfide bonds, hydrogen bonds, hydrophobic and ionic interactions stabilize the tertiary structure of proteins.



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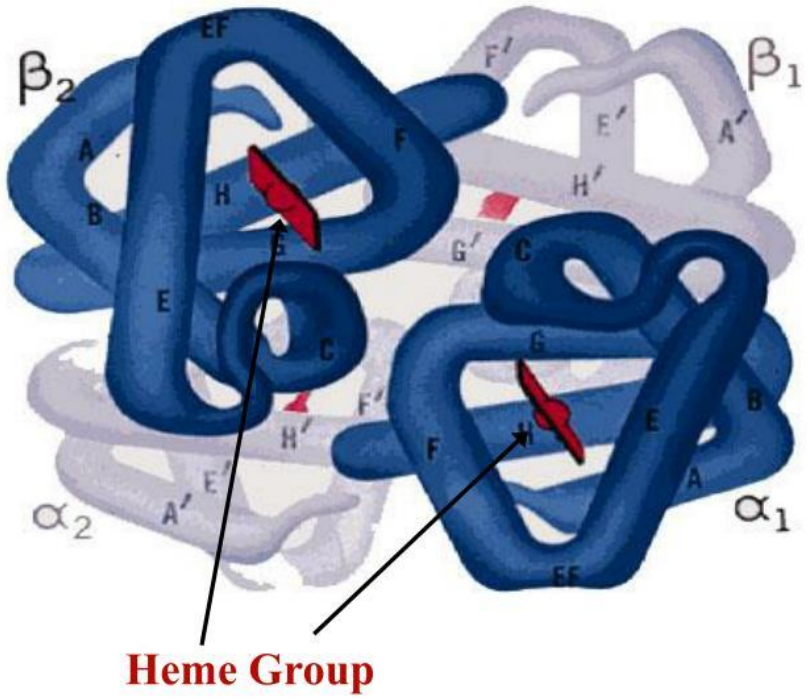
Quaternary structure of Proteins

Some proteins contain two or more separate polypeptide chains or subunit (oligomeric proteins) which may be identical or different. The arrangement of these proteins subunits in three-dimensional complexes constitutes quaternary structure.

Disulfide bonds, hydrogen bonds hydrophobic, and ionic interaction stabilize the quaternary structure.

Hemoglobin contains four polypeptide chains and four heme prosthetic groups. The protein portion called globin consists of two Alpha chains and two beta chains .

Hemoglobin: Quaternary Structure



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Denaturation of Proteins

Changes in the protein's environment can bring about structural changes in proteins that can cause loss of function, called denaturation.

Most proteins can be denatured by

- heat,
- extremes of PH,
- organic solvents such as alcohol or acetone,
- solutes such as urea or by detergents

Each of these denaturing agent represent a relatively mild treatment in the sense that no covalent bonds in the polypeptide chain are broken.

Denaturation of Proteins

- ➔ heat affect hydrogen bonds
- ➔ extremes of pH alter the net charge on the protein, causing electrostatic repulsion and the disruption of some hydrogen bonding.
- ➔ organic solvent urea and detergents disrupt the hydrophobic interactions.

Let’s revise

1. Describe the properties of peptide bond.
2. Write a note on alpha helical structure of proteins.
3. Describe parallel and antiparallel beta sheet structure of proteins.
4. What are the forces that stabilise tertiary structure of proteins
5. What do you understand by denaturation of proteins?

RECOMMENDED BOOKS: