PROTEIN

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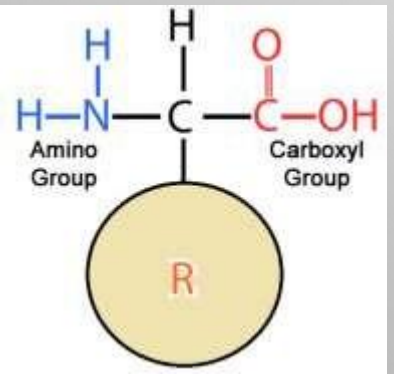
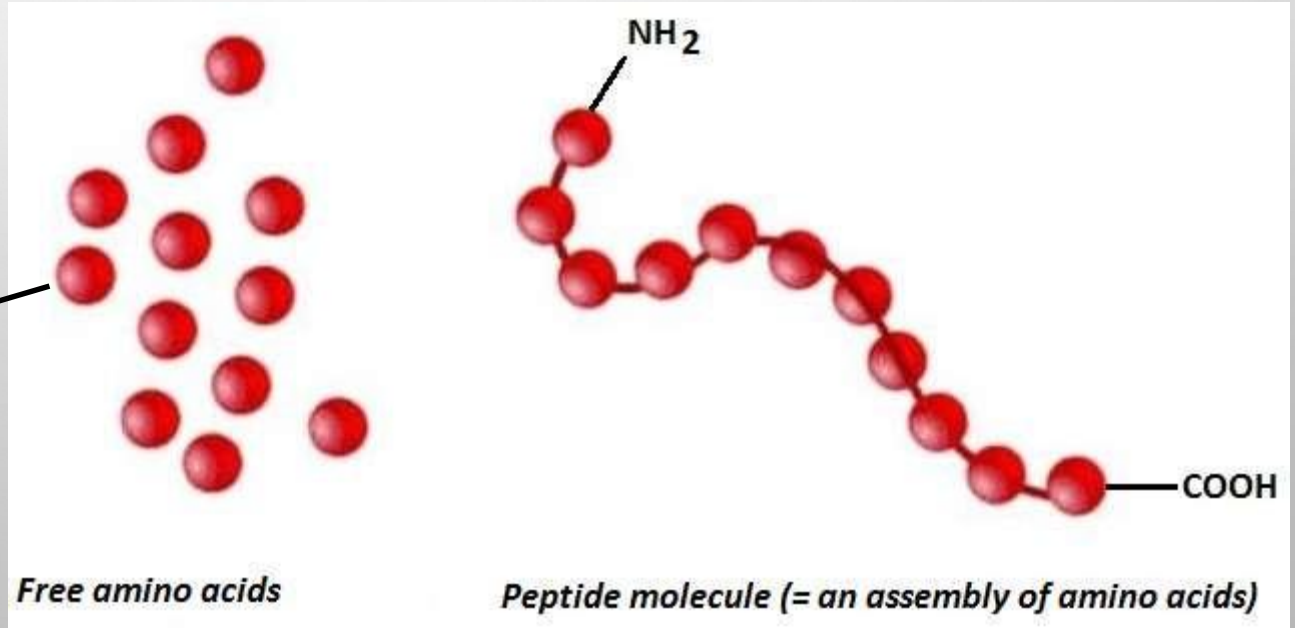
DEFINITION OF THE PROTEIN

- The proteins are the more complex molecules in the living cells.
- Proteins are the long chain of amino acids.
- ***A protein*** *is a biological macromolecule composed by one or several* ***peptides.***
- ***A peptide*** *is a polymer (= chain) of* ***amino acids (AA)*** *linked between them by* ***a peptide bond.***





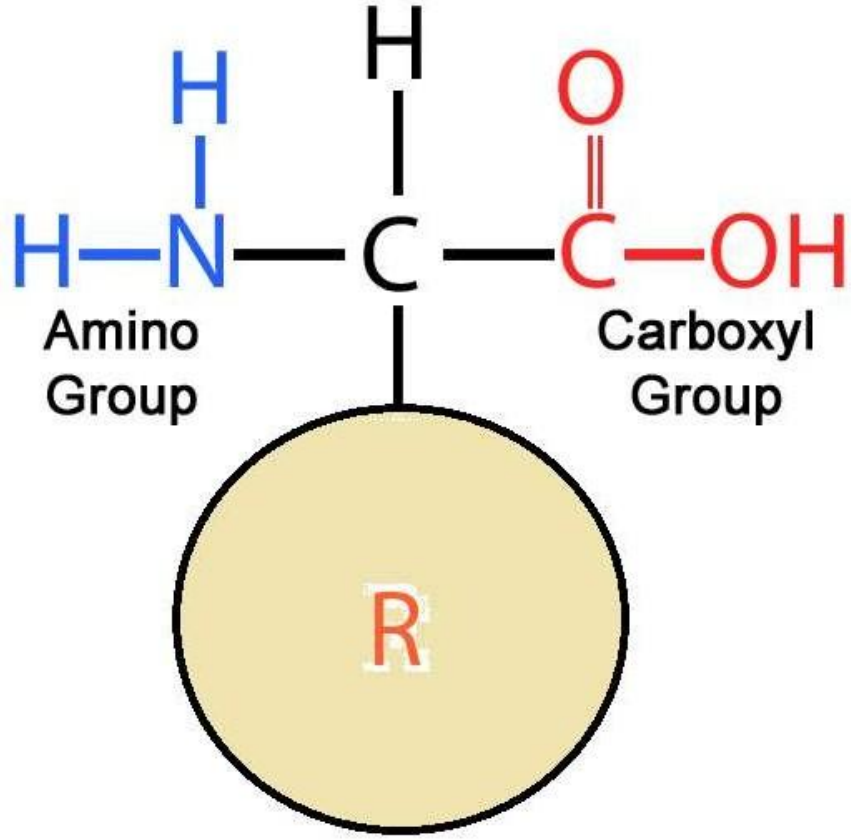
THE AMINO ACID

The amino acid is the basic unity of the protein.

The amino acid is composed by a carbone (C) on which is linked:

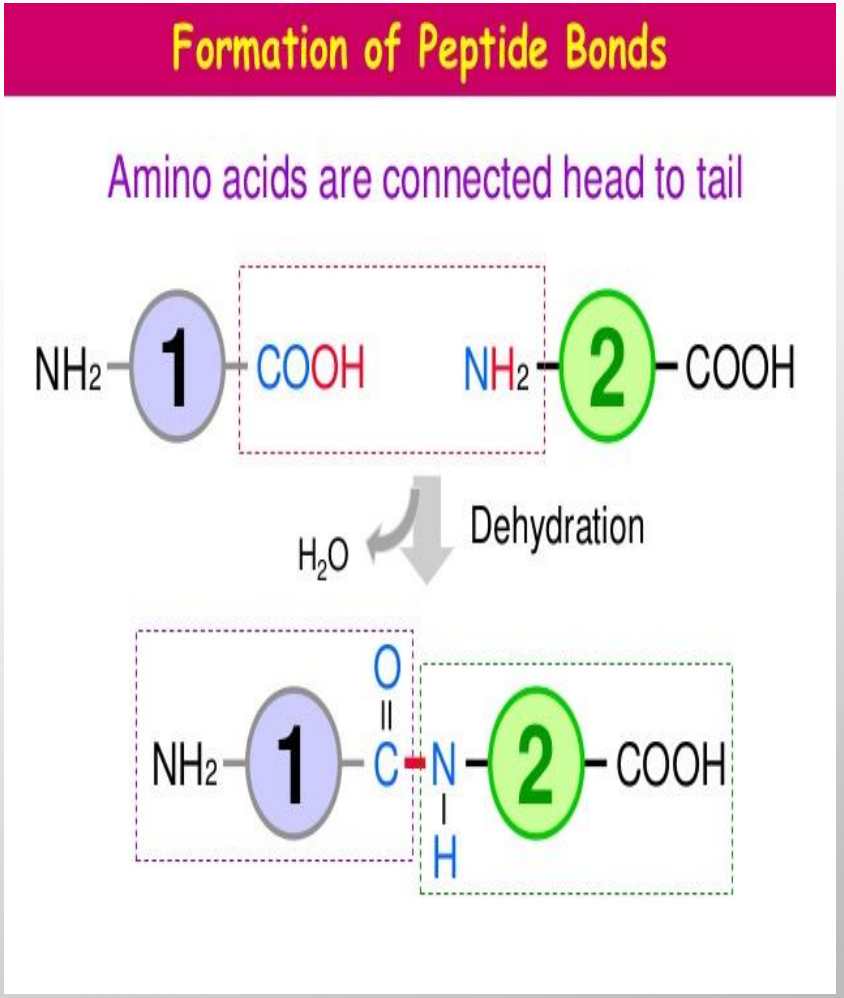
- ***An amino group (NH2)***
- ***An acid group (COOH)***
- ***A variable chemical group (R)***
- ***A hydrogen (H)***

Its also called Zwitter Ion– both acidic and basic functional group

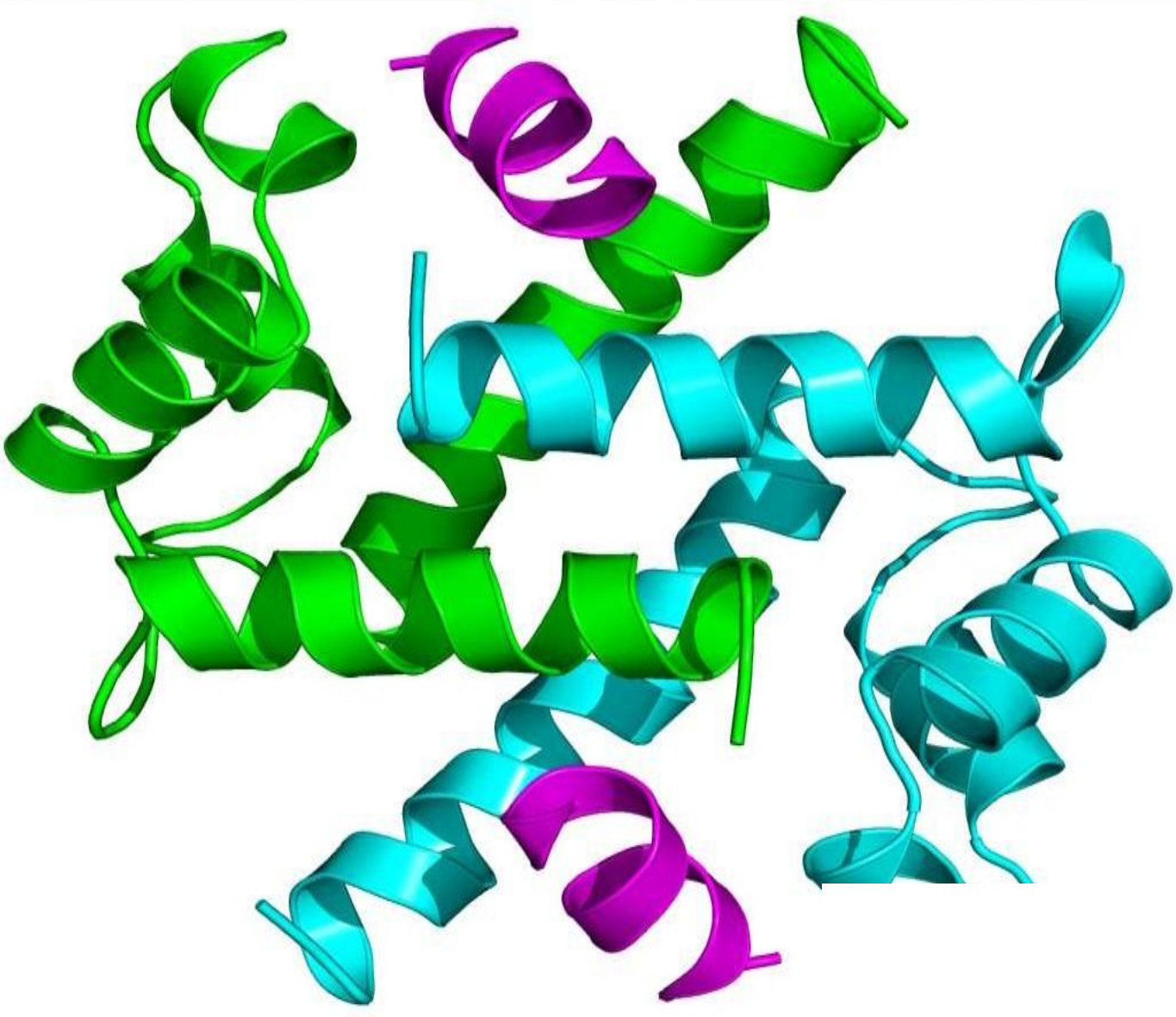


PEPTIDES

- Two AA covalently joined through a substituted amide linkage – **peptide bond**
- **Dehydration** – removal of H_2O
  - OH^- Carboxyl group of one AA
  - H^+ from amino group of another AA.
- The amino acid (AA) molecules are linked each other one by peptide bonds.
- A peptide bond is a covalent bond between the carboxylic group (CO) of one amino acid and the amino group (NH2) of another amino acid molecule.
- The formation of a peptide bond releases a water molecule (H2O) = reaction of condensation.



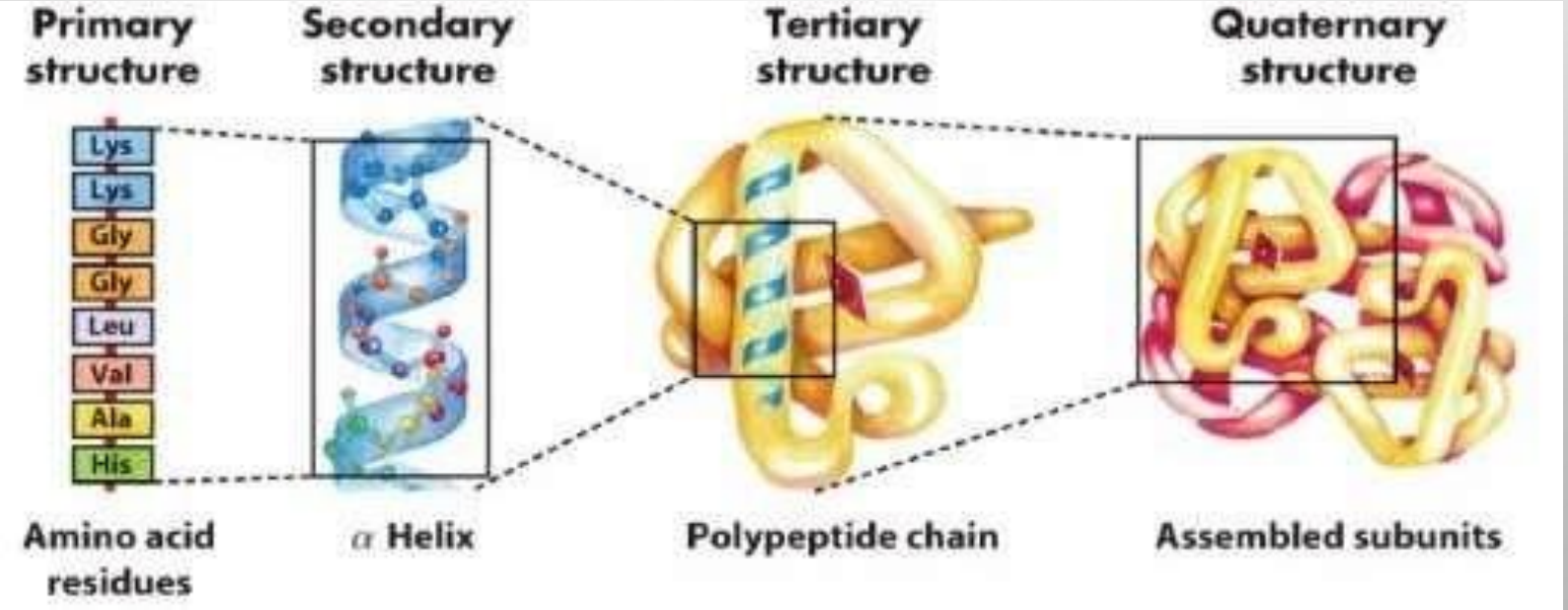
STRUCTURE OF PROTEINS



STRUCTURAL ORGANIZATION OF PROTEINS

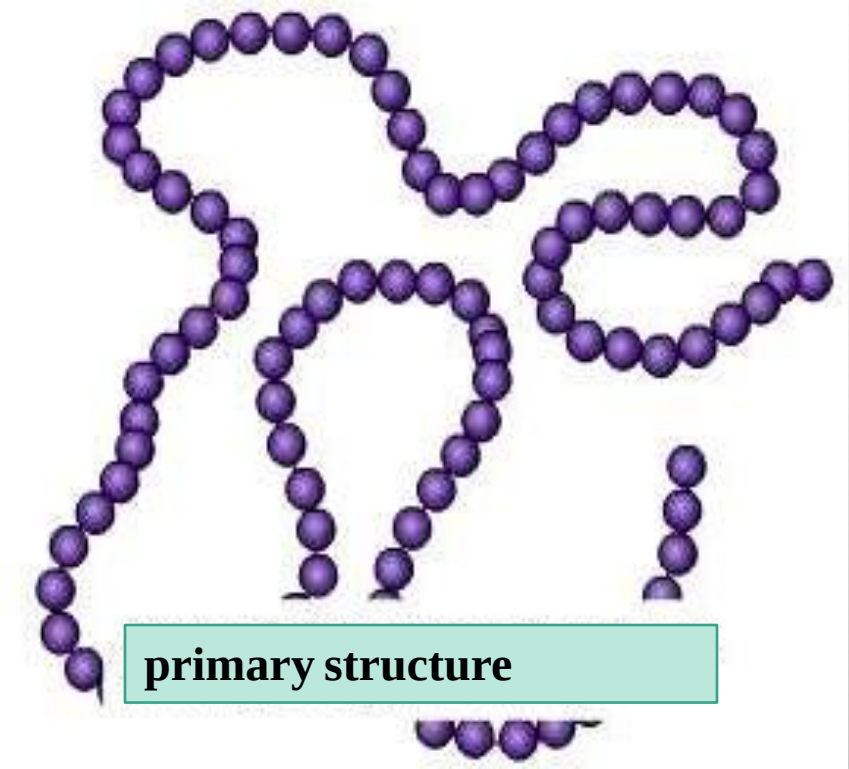
The structural and functional features of proteins and protein complexes are addressed at four levels of hierarchal organization. These are:

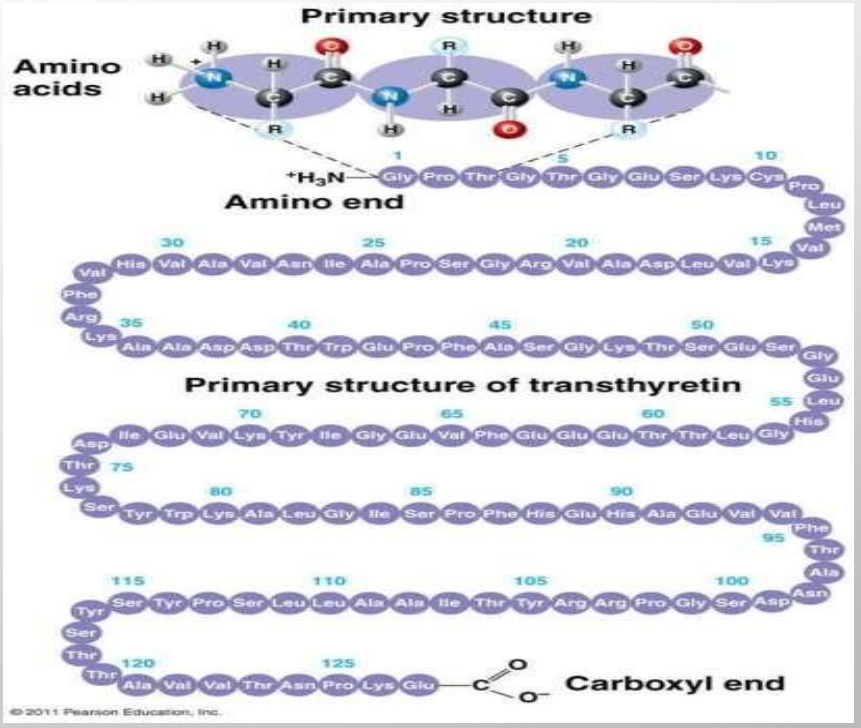
1. Primary structure (1^{o}-Structure)
2. Secondary structure (2^{o}-Structure)
3. Tertiary structure (3^{o}-Structure)
4. Quaternary structure (4^{o}-Structure)



PRIMARY STRUCTURE

- The primary structure of protein refers to the sequence of amino acids present in the polypeptide chain. Amino acids are covalently linked by peptide bonds. Each component amino acid in a polypeptide is called a “residue” or “moiety”
- By convention, the 1^0 structure of a protein starts from the amino-terminal (N) end and ends in the carboxyl-terminal (C) end.

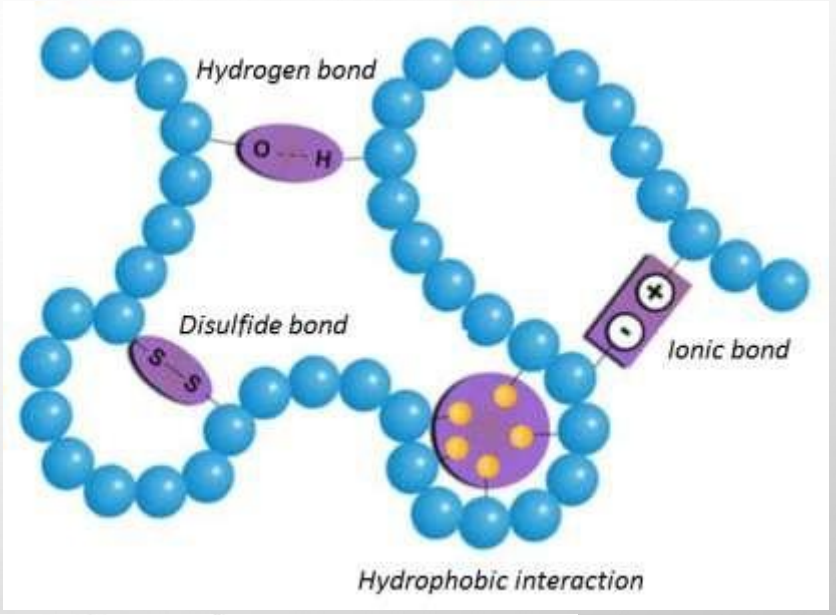




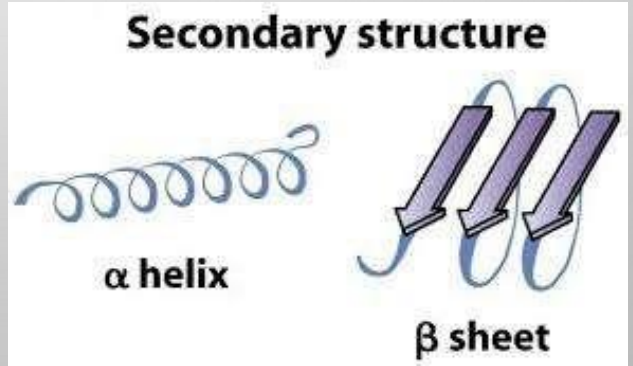
THE SECONDARY STRUCTURE

•*The variable chemical groups (R) of the AA have differents properties: Hydrophobic, hydrophilic, charges (+) or (-).*

Intramolecular chemical interactions: Hydrogen bonds, Disulfide bridges, Ionic bonds, hydrophobic and hydrophilic interactions…

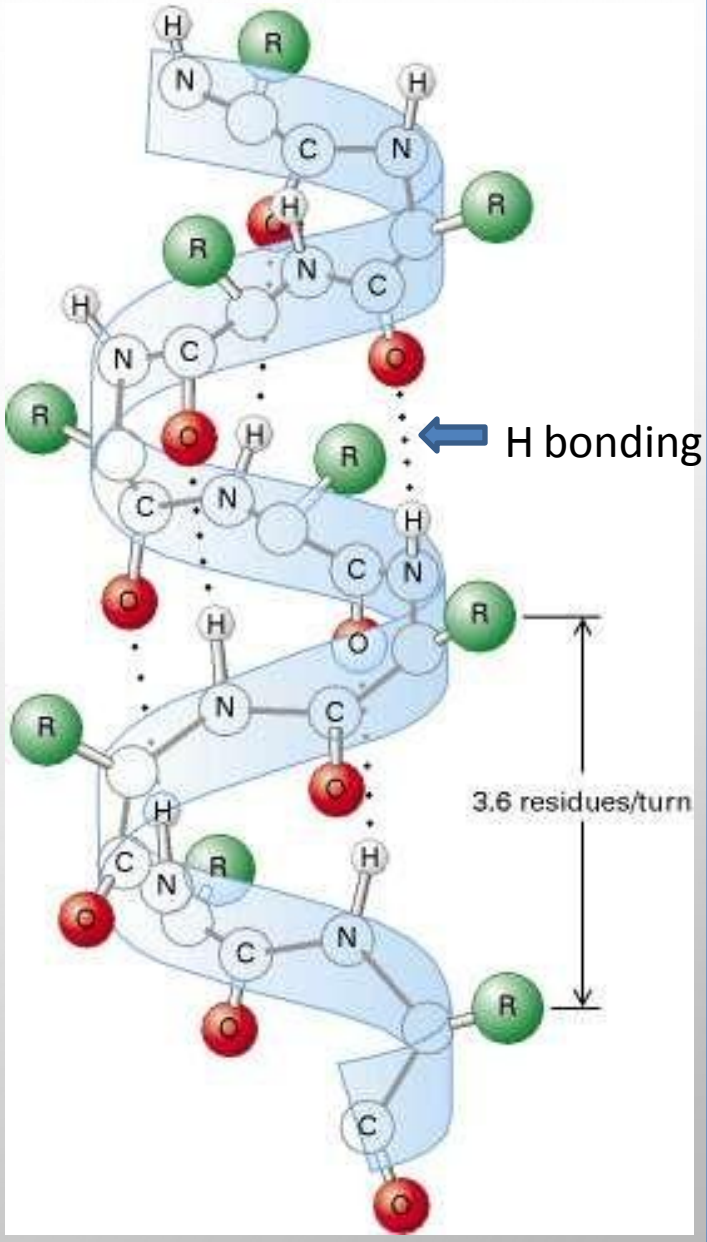


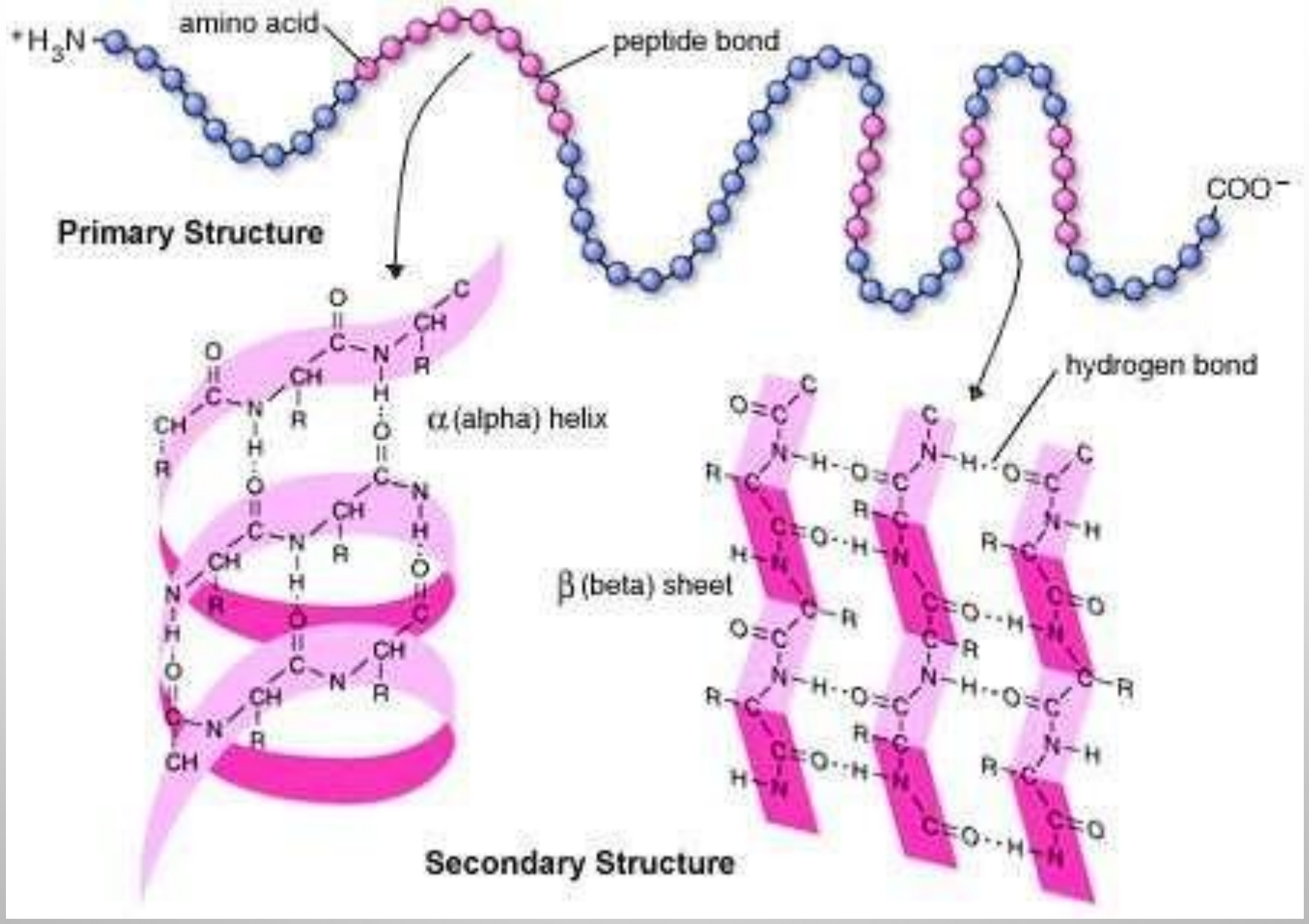
Alpha-helice *and* ***Beta-sheet*** *structures*



ALPHA HELIX

- Spiral structure
- Tightly packed, coiled polypeptide backbone core.
- Alpha helical segments are found in many globular proteins like myoglobins.
- α helix is twisted by an equal amount about each α- carbon Complete turn of the helix contains aminoacyl residues.
- Stabilize by Hydrogen bond.

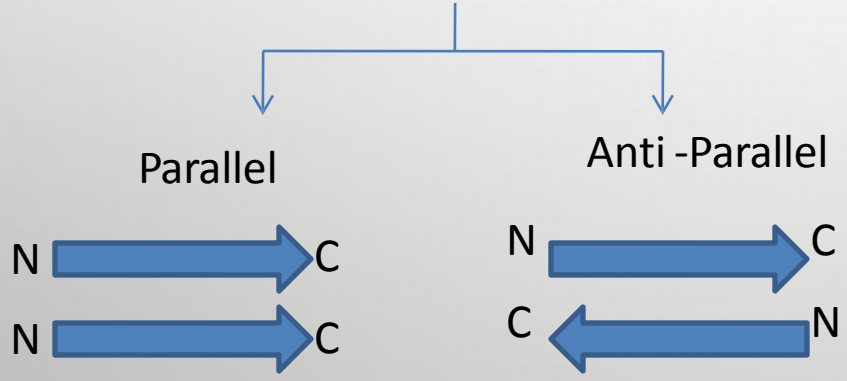


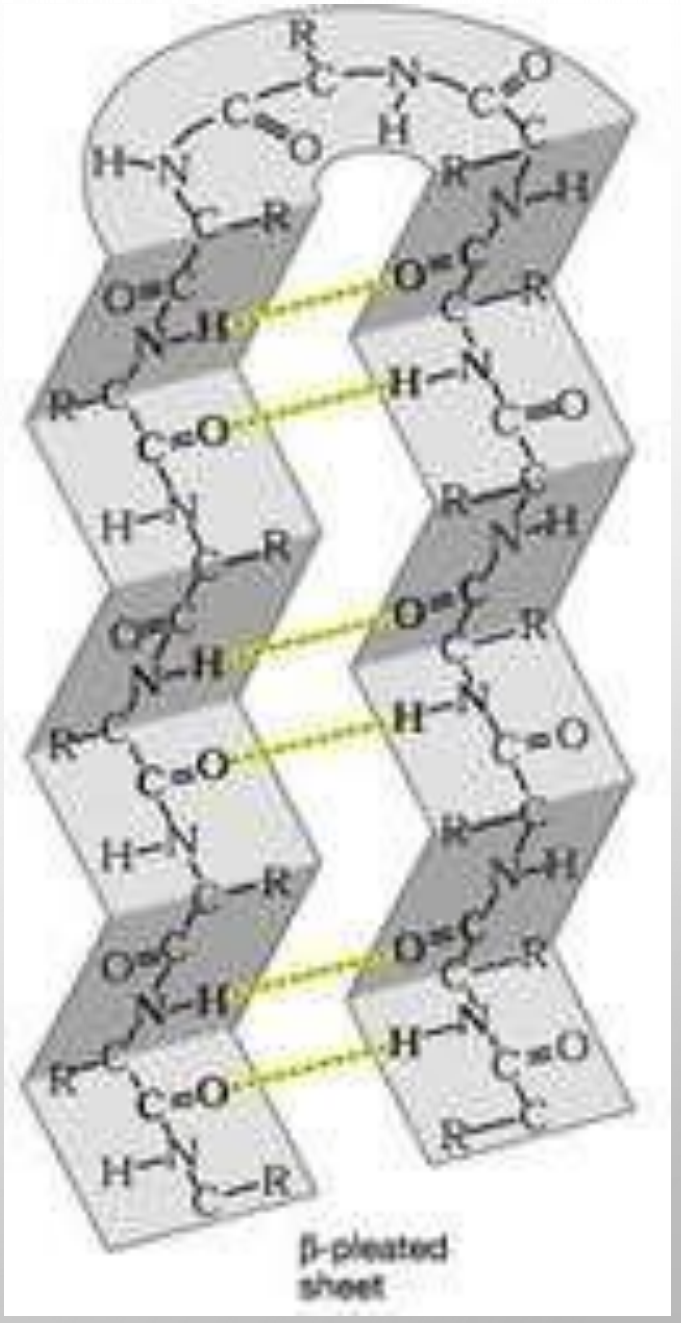

*H3N
amino acid
peptide bond
COO−
Primary Structure
α (alpha) helix
hydrogen bond
β (beta) sheet
Secondary Structure

BETA PLEATED SHEET

- Formed when 2 or more polypeptides line up side by side.
- Individual polypeptide - β strand
- Each β strand is fully extended.
- They are stabilized by H bond b/w N-H and carbonyl grps of adjacent chains.

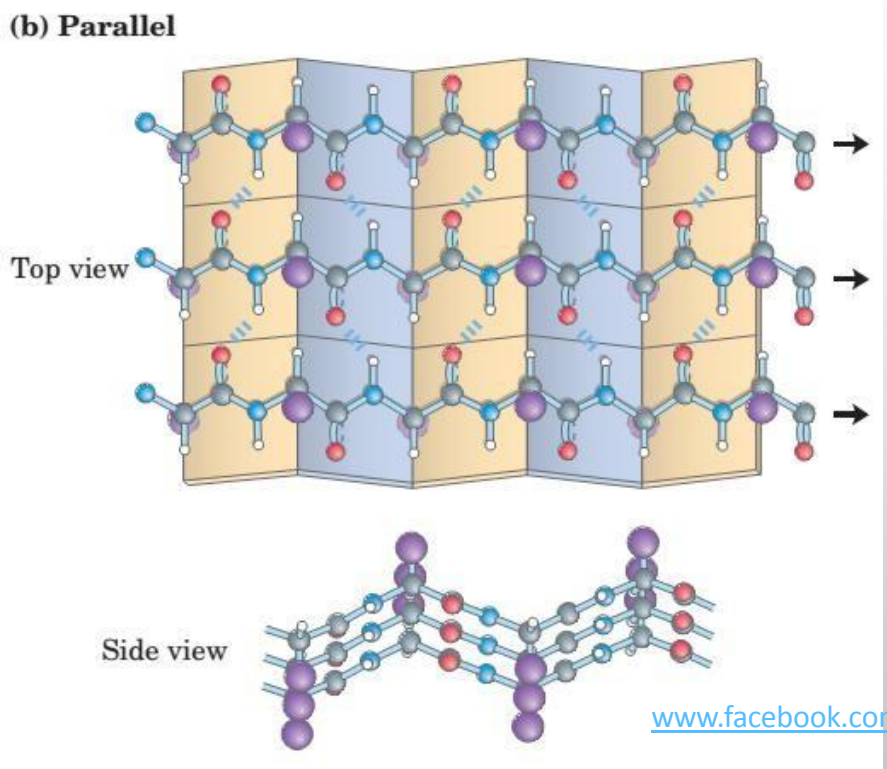
2 types

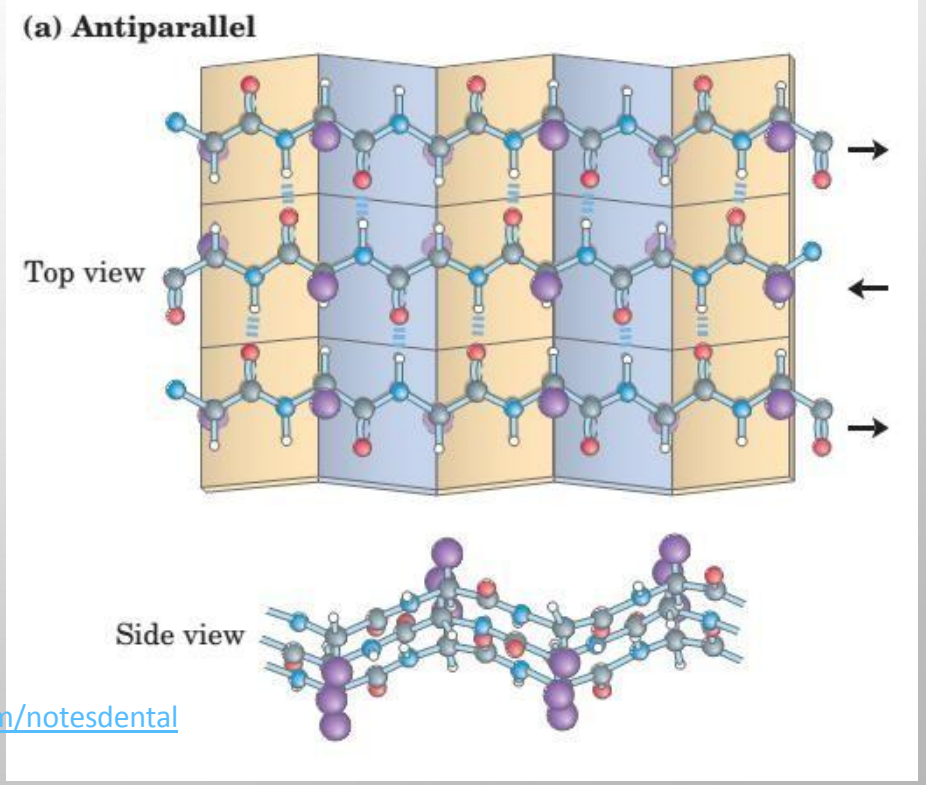




SECONDARY STRUCTURE : BETA SHEET

- **Parallel:**polypeptide chain proceed in the same direction amino to carboxyl.
- **Antiparallel:** they proceed in opposite directions



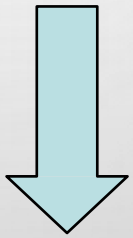


THE TERTIARY STRUCTURE

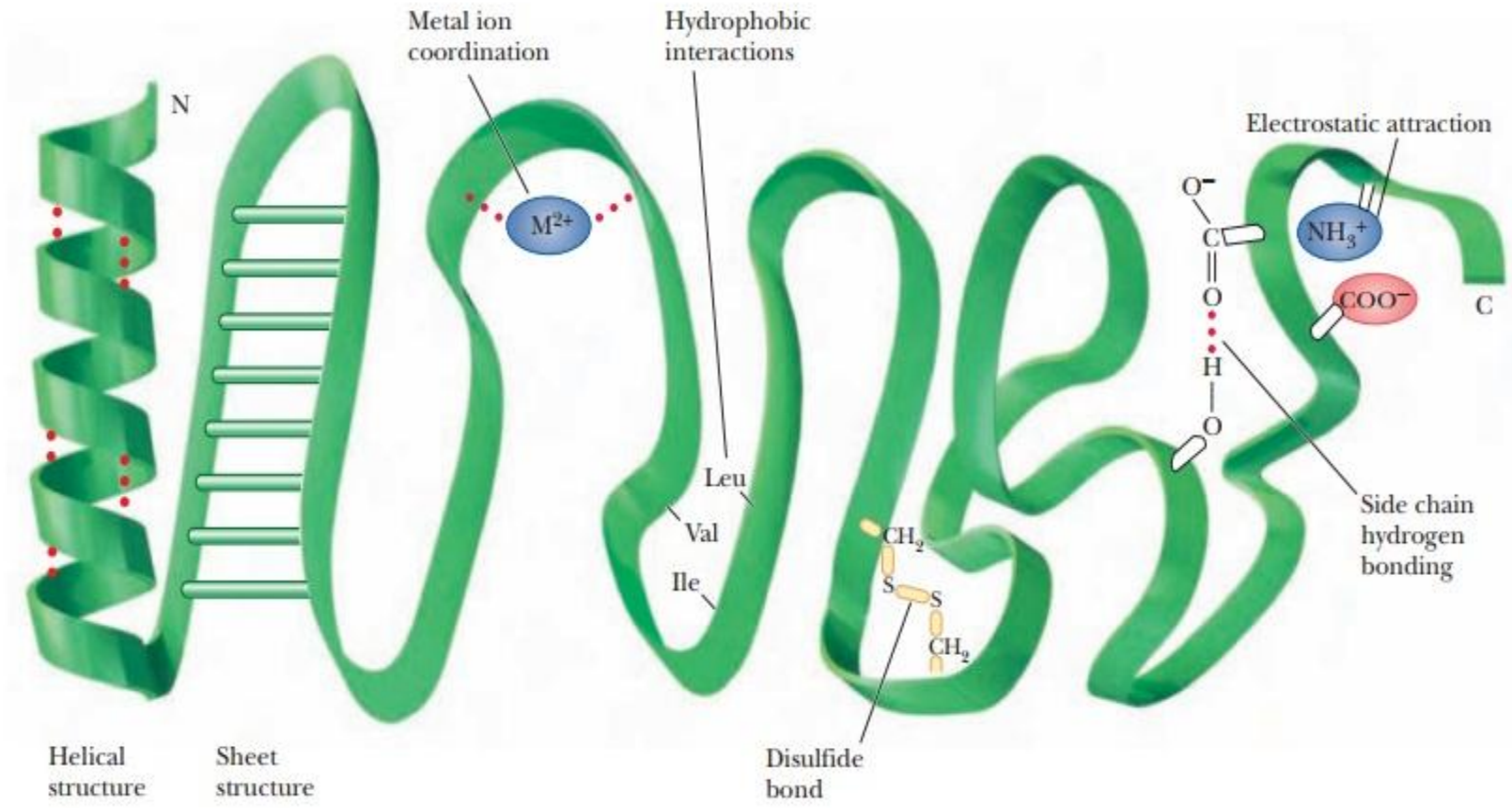
- The tertiary structure is the final form of the protein.

- The function of the protein is strongly related to its final form (structure).

- The final structure can be destroyed in case of a heating process or extrem pH = **Denaturation process**



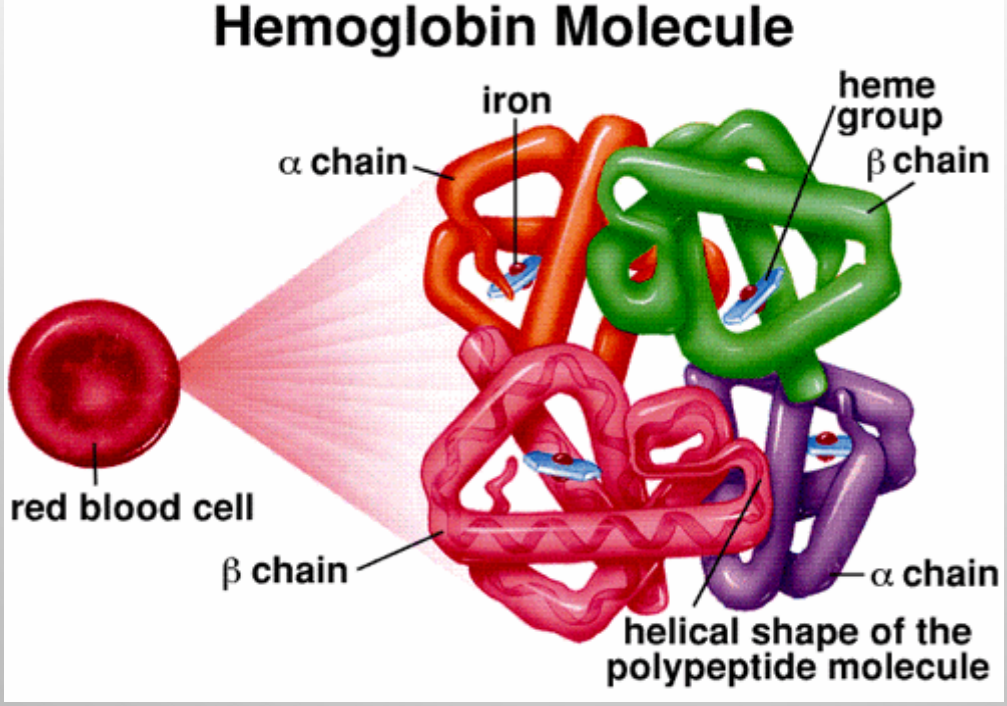
Biological function is lost!



■ **FIGURE 4.13 Forces that stabilize the tertiary structure of proteins.** Note that the helical structure and sheet structure are two kinds of backbone hydrogen bonding. Although backbone hydrogen bonding is part of secondary structure, the conformation of the backbone constrains the possible arrangement of the side chains.

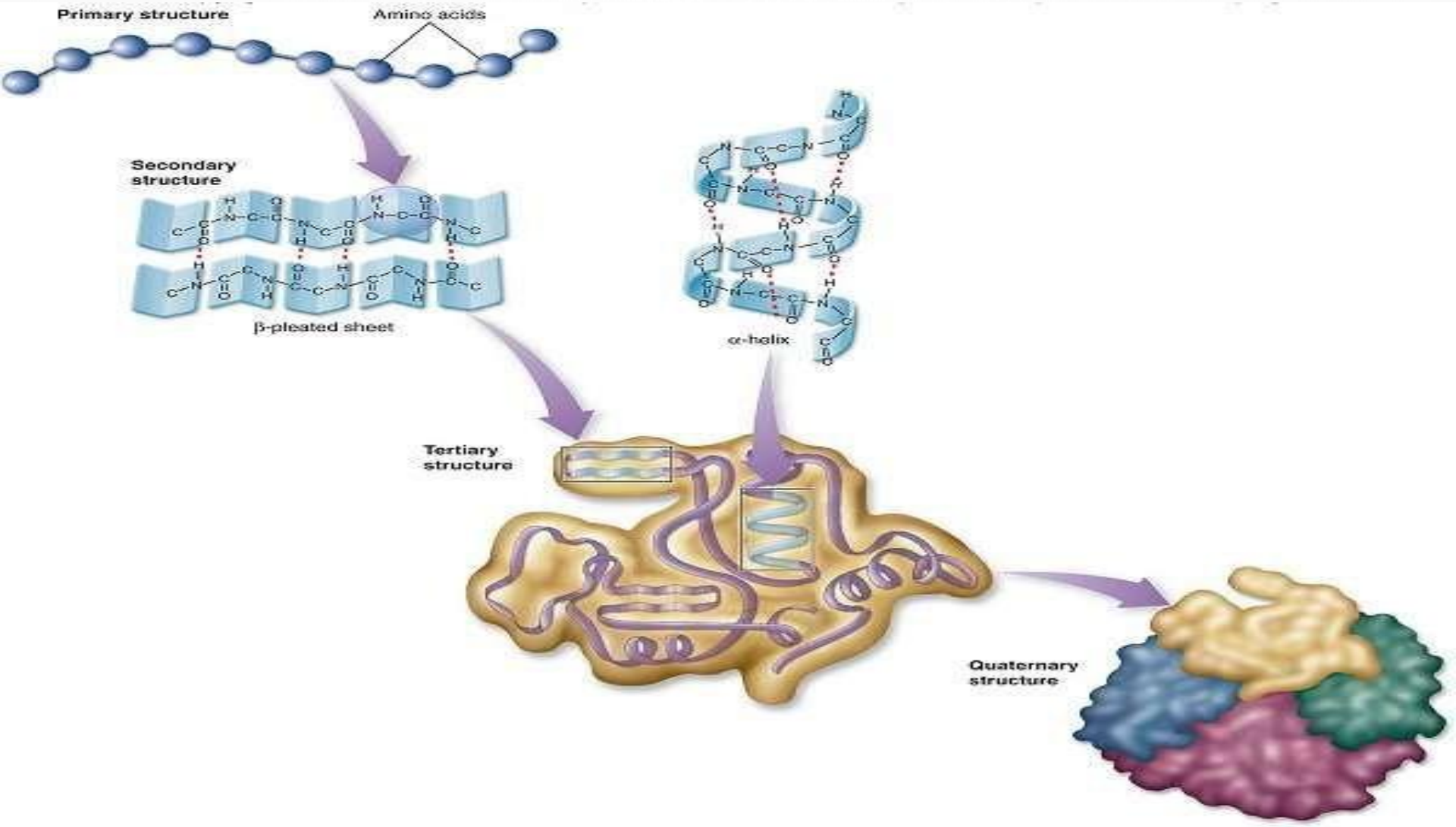
HEMOGLOBIN

- Hemoglobin is a tetramer composed of two each of two types of closely related subunits, alpha and beta.
- Hemoglobin transport O_2 from lungs to tissues.
- Hemoglobin is hydrophilic.



- **THE QUATERNARY STRUCTURE**
- only those protein that have more than one polypeptide chain (polymeric)in their native conformation have quaternary structure .
- Single polypeptide chain called as Monomeric protein.
- The arrangement of these polypeptide subunit in three dimensional complex is called as quaternary structure of protein

THE QUATERNARY STRUCTURE



THE PROTEIN STRUCTURE

CLASSIFICATION

- Proteins are classified on the basis of
  - **Chemical nature and solubility**
    - Simple
    - Conjugates
    - Derived
  - **Function**
    - Structural
    - Enzyme or catalytic
    - Transport
    - Hormonal
    - Contractile
    - Storage
    - Genetic
    - Defense
    - Receptor

CHEMICAL NATURE AND SOLUBILITY

- They are composed of only amino acid residues
- They are again classified as
  - **Globular Protein :** spherical or oval in shape, soluble in water or other solvent and digestible
    - **Globulin:** soluble in neutral and salt solution. Ex: serum globulin
    - **Albumin:** soluble in water and dilute salt solutions and cogulated by heat. Ex: serum albumin, ova albumin, lactalbumin

CHEMICAL NATURE AND SOLUBILITY

- **Fibrous Protein**: fiber like in shape, insoluble in water and resistant to digestion.
- **Collagen:** connective tissue protein lacking tryptophan. On heating with boiling water or acids it turns to soluble **gelatin**
  - **Keratin:** present in the exoskeleton structures.
  - Ex: hair, nails,

CHEMICAL NATURE AND SOLUBILITY : CONJUGATE PROTEIN

- Beside amino acid, it contains a non-protein moiety known as prosthetic group or conjugating group. Its again of 6 types
  - **Nucleoprotein**: nucleic acid (DNA or RNA)
  - **Glycoprotein:** prosthetic group is carbohydrate
  - **Lipoprotein:** found in the conjugation with lipids. Ex: serum lipoprotein, membrane lipoprotein

CONT…

- **Phosphoprotein:** phosphoric acid as conjugate. Ex: casein(milk).
- **Chromoprotein:** prosthetic group is colored in nature. Ex: Hemoglobins, cytochromes
- **Metalloprotein:** it contains metal ions such as Fe, Co, Zn, Cu, Mg.

CHEMICAL NATURE AND SOLUBILITY : DERIVED PROTEIN

- Denatured or degraded product of simple or conjugated protein
- Its of 2 types
  - **Primary derived protein:** denatured or cogulated or first hydrolyzed product of proteins. They are
    - **Cogulated proteins:** denatured protein produced by agents such as heat, acids, alkalies
  - **Secondary derived protein:** progressive hydrolytic product of protein hydrolysis. Ex: proteoses, peptones, polypeptides and peptides

DENATURATION

- The phenomenon of disorganization of **native protein structure**
- It results in the loss of secondary, tertiary and quaternary structure of proteins.
- It involves the change of physical, chemical and biological properties
- **Agents of Denaturation**
  - **Physical agents:** Heat, UV radiation, X-rays and violent shaking (centrifuge)
  - **Chemical Agents:** Acids, alkalies, organic solvents (ether, alcohol), salts of heavy metals, urea, salicylate

DENATURATION

- **Coagulation**
  - Irreversible denaturation of protein to semi-solid viscous precipitate
  - Albumins and globulins – coagulable proteins
- **Flocculation**
  - Protein precipitation at isoelectric pH.
  - Precipitate is known as flocculum

THANK YOU