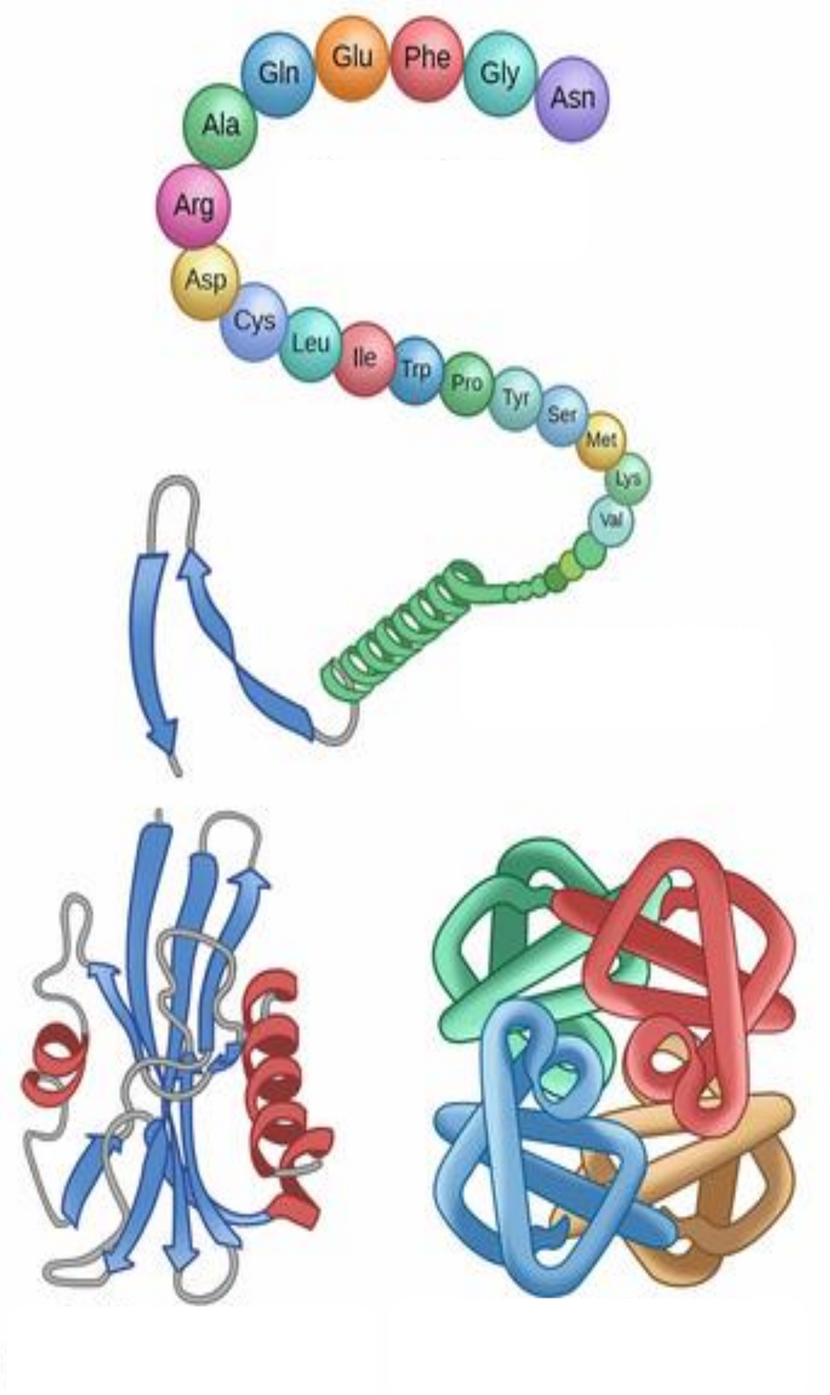
Proteins


Gln
Glu
Phe
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Lys
Val

Proteins are large biomolecules consisting of one or more long chains of amino acids that linked by peptide bonds. There are 20 amino acids that help form the thousands of different proteins in your body.

A typical human cell contains 9000 different proteins; the human body contains about 100,000 different proteins.

Classification of proteins

Classification by Structural Shape

Proteins can be classified on the basis of their structural shapes:

1. **Fibrous proteins** are made up of long rod-shaped or string-like molecules that can intertwine with one another and form strong fibers.

–insoluble in water

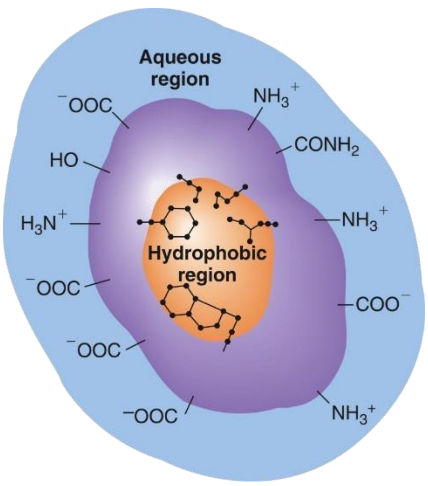
–major components of connective tissue, elastic tissue, hair, and skin

–e.g., collagen, elastin, and keratin.

2. **Globular proteins** are more spherical in shape

–dissolve in water.

–e.g., hemoglobin and transferrin.

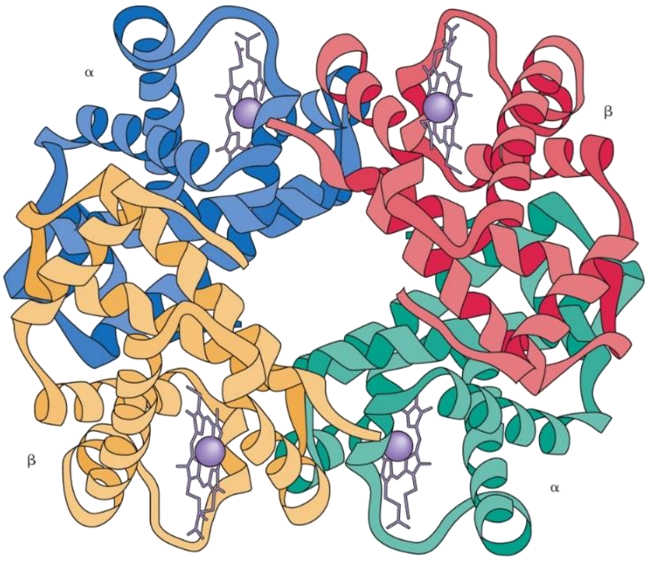


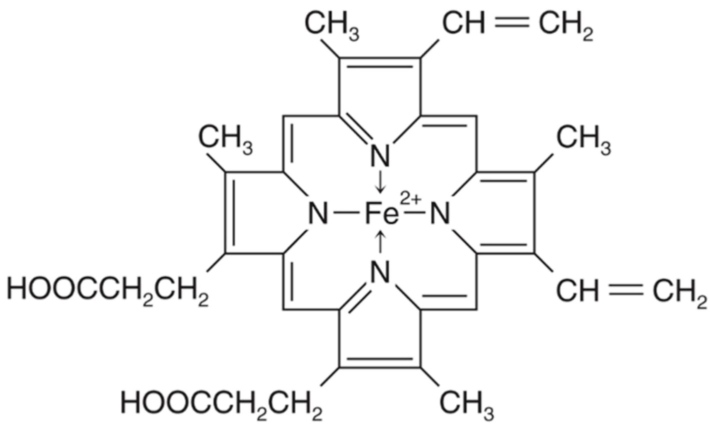
Classification by Composition

Proteins can also be classified by composition:

1. **Simple proteins** contain only amino acid residues.
2. **Conjugated proteins** also contain other organic or inorganic components, called **prosthetic groups**.

–**hemoproteins** — heme (hemoglobin, myoglobin, cytochromes)





Protein Structure

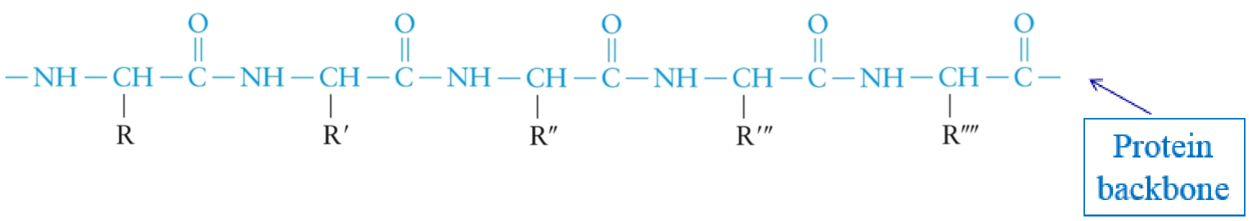
Many protein molecules consist of a chain of amino acids twisted and folded into a complex three-dimensional structure.

The complex 3D structures of proteins impart unique features to proteins that allow them to function in diverse ways.

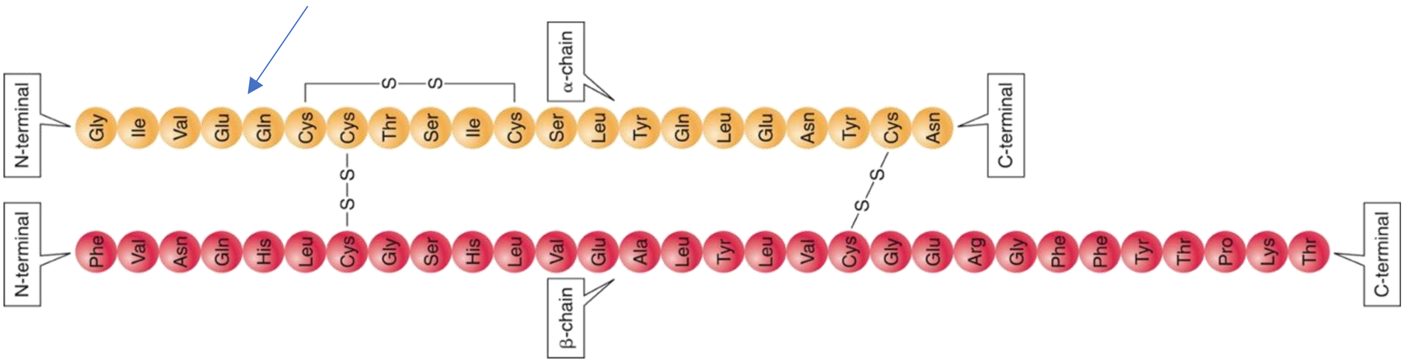
There are four levels of organization in proteins structure: primary, secondary, tertiary, and quaternary.

1. primary structure

The primary structure of a protein is the sequence of amino acids in the peptide chain.



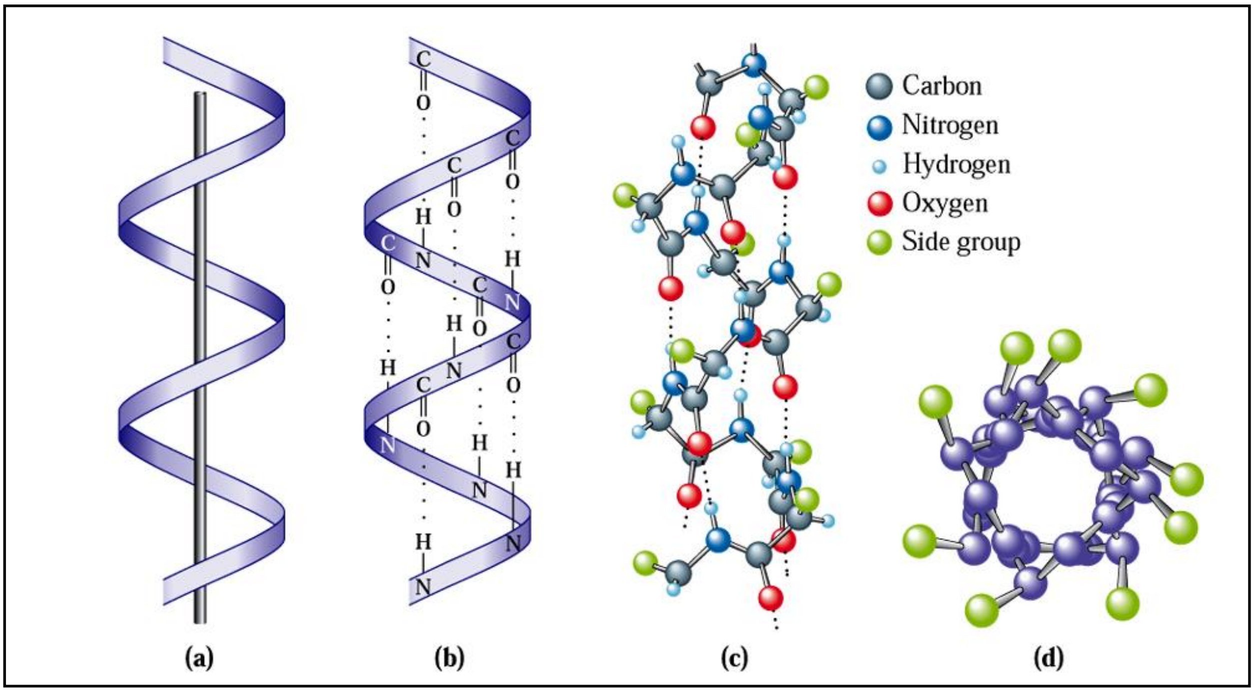
Primary structure of human insulin



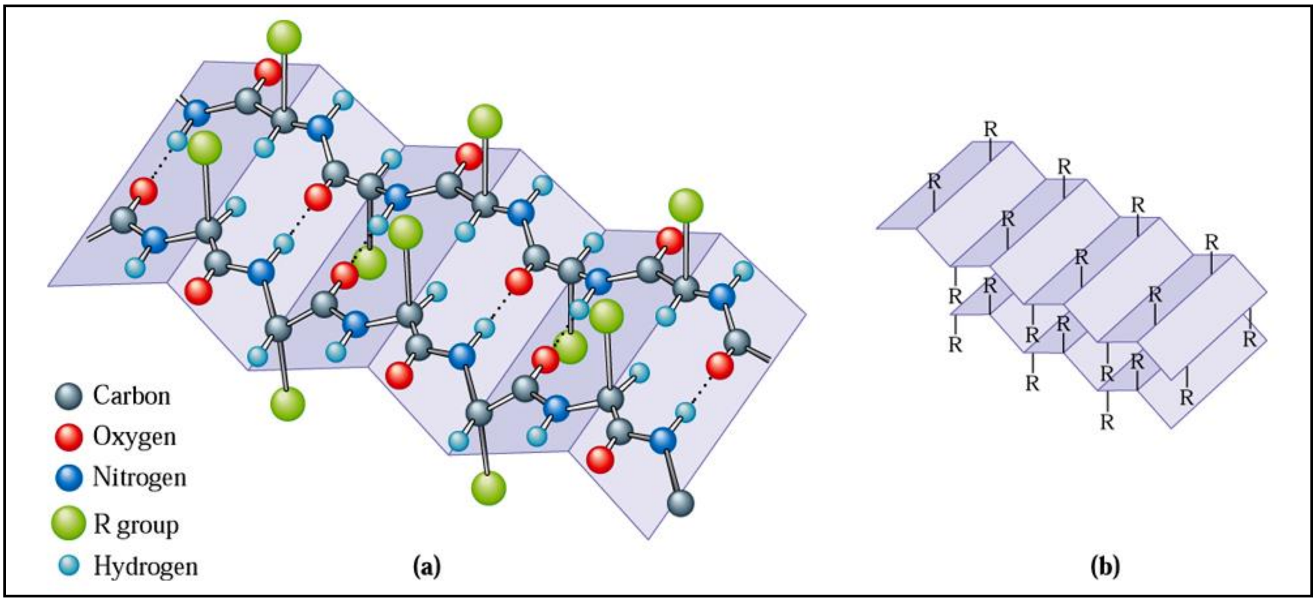
2. Secondary structure

The secondary structure of a protein is the arrangement of the polypeptide chains in orderly way to give two shape:

a. α-helix: is a three-dimensional arrangement of the polypeptide chain that twisted to resemble a coiled helical spring. The coiled shape of the alpha helix is **stabilized** by hydrogen bonds between the amide groups and the carbonyl groups of the amino acids along the chain.



b. β-pleated sheet: protein chains lie side by side (parallel arrangement) which held by hydrogen bonds between adjacent chains. It typical of fibrous proteins such as silk.



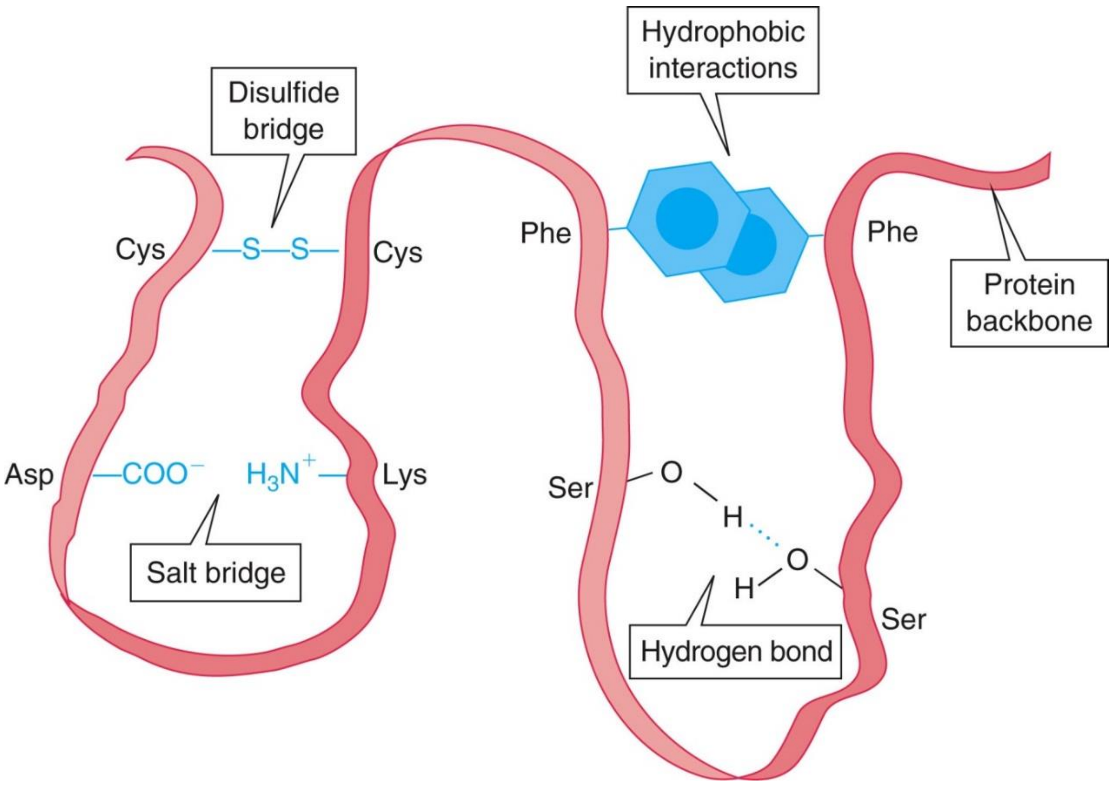
3. Tertiary Structure

The **tertiary structure** of a protein refers to the bending and folding of the protein into a specific three-dimensional shape.

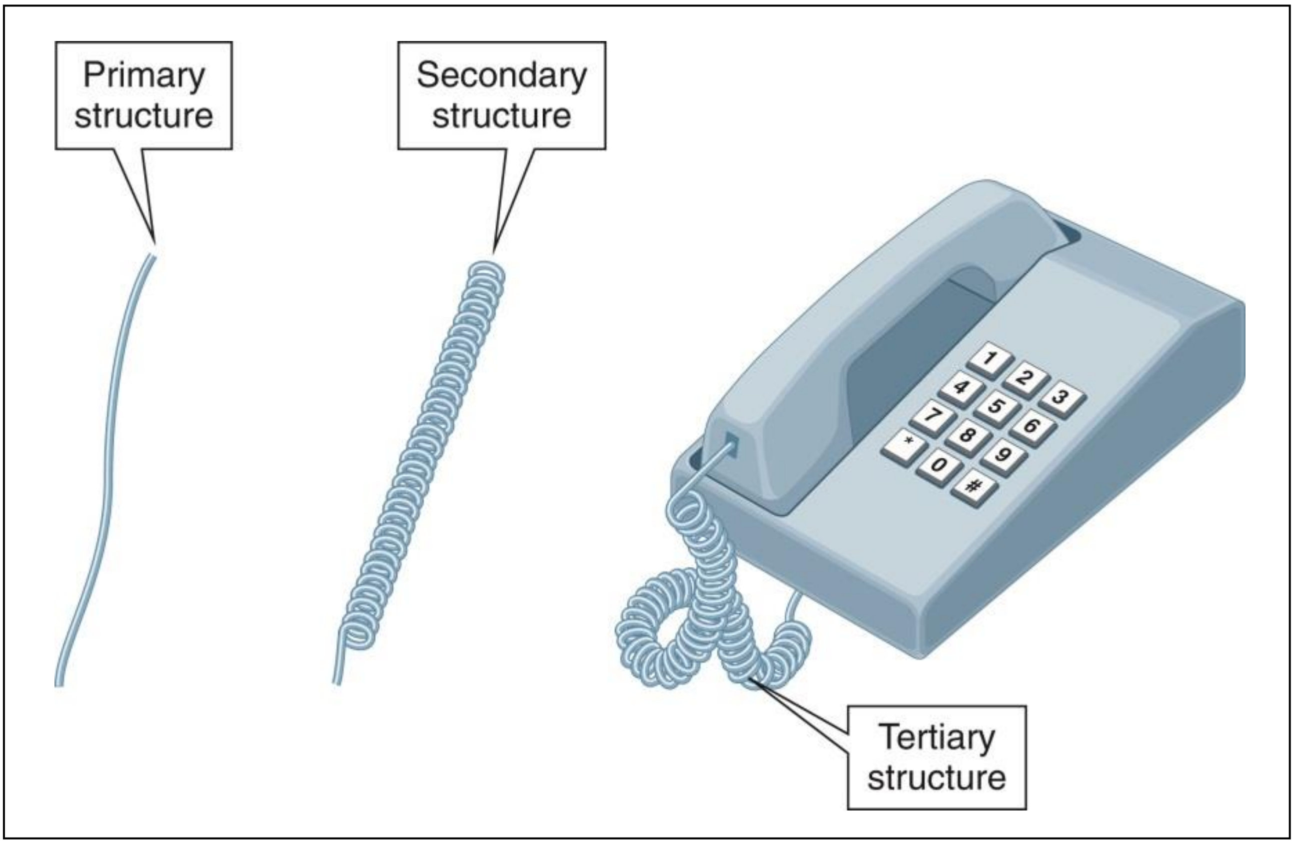
The **tertiary structure** stabilized by:

- Hydrophobic and hydrophilic interactions
- Salt bridges (electrostatic interactions)
- Hydrogen bonds
- Disulfide bridges

	Nature of Bonding	Example
Hydrophobic interactions	Attractions between nonpolar alkyl and aromatic groups form a nonpolar center that is repelled by water	$—CH_3$ $CH_3—$
Hydrophilic Interactions	Attractions between polar or ionized R groups and water on the surface of the tertiary structure	$—CH_2OH \cdots O—H$ (with H on O)
Salt bridges	Ionic interactions between ionized R groups of acidic and basic amino acids	$—\overset{O}{\overset{\|\|}{C}}O^- \cdots H—\overset{+}{N}—$
Hydrogen bonds	Occur between polar side groups of amino acids	$>C{=}O \cdots HO—$; $>C{=}O \cdots H—N—$
Disulfide bonds	Strong covalent links between sulfur atoms of two cysteine amino acids	$—SH + HS— \rightarrow —S—S—$



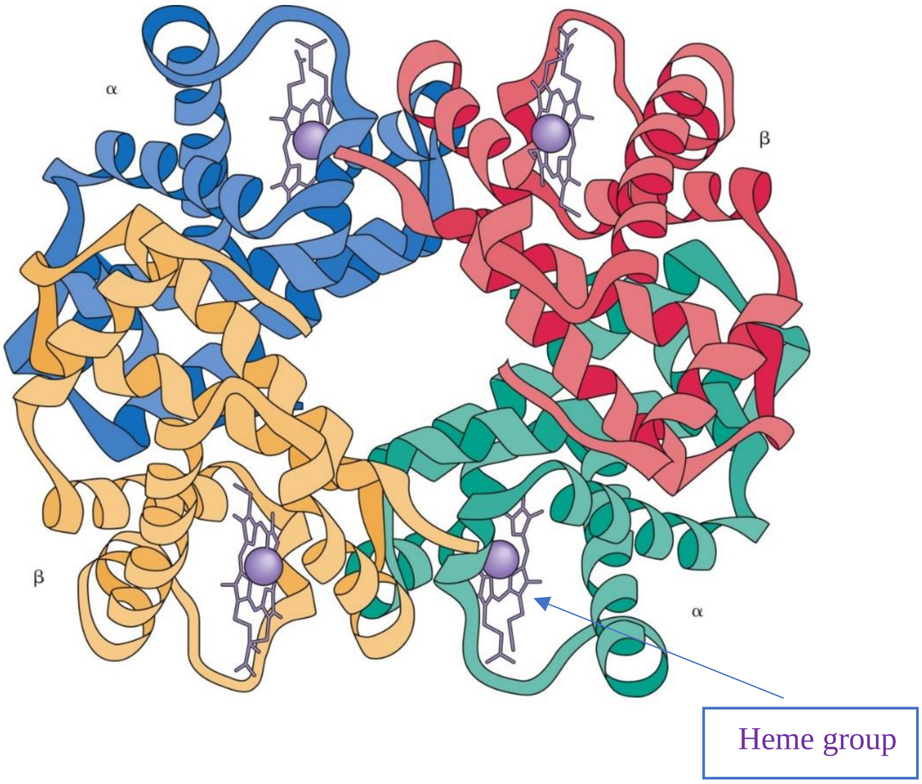
Visualizing Protein Structure



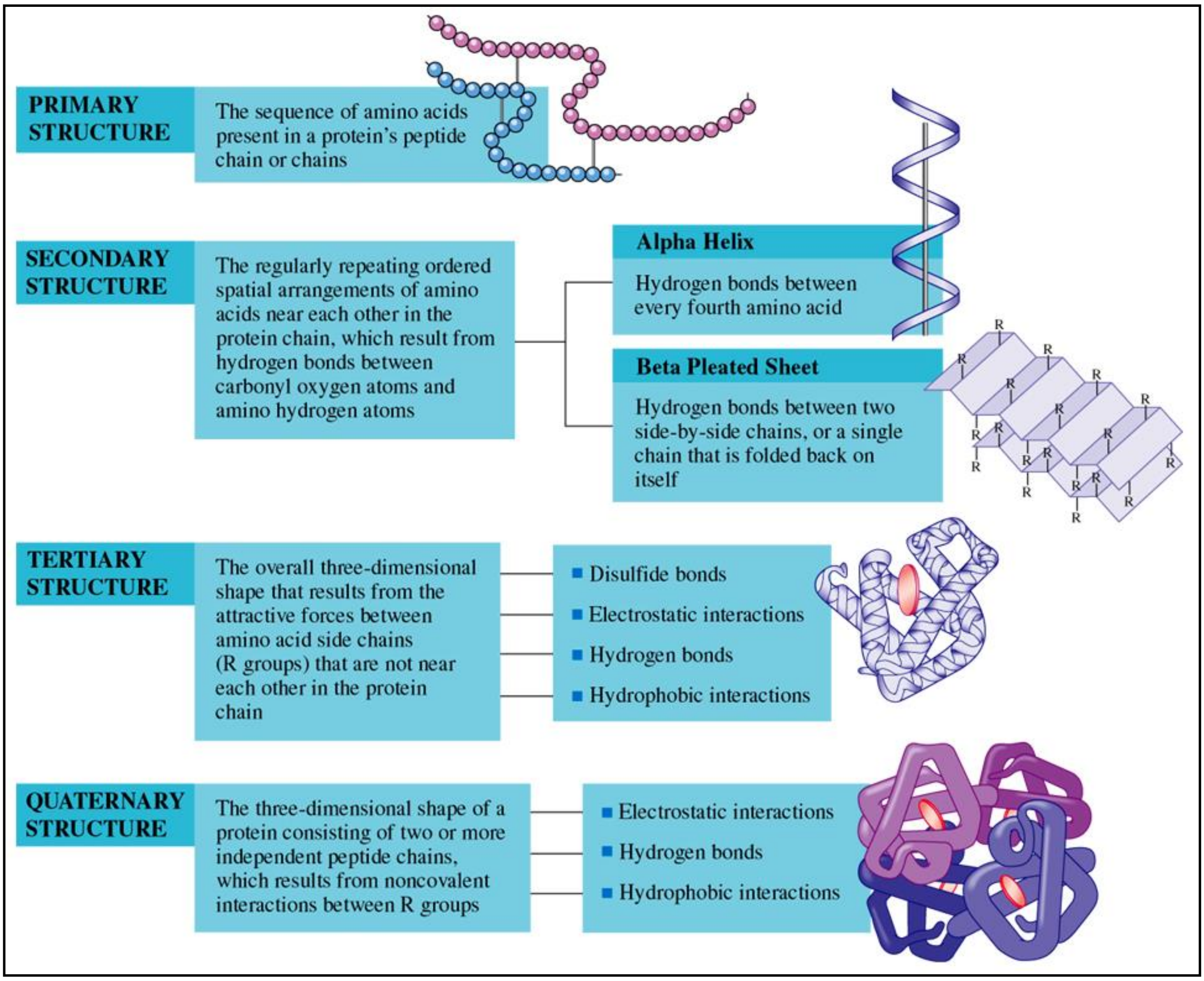
4. Quaternary Structure of Proteins

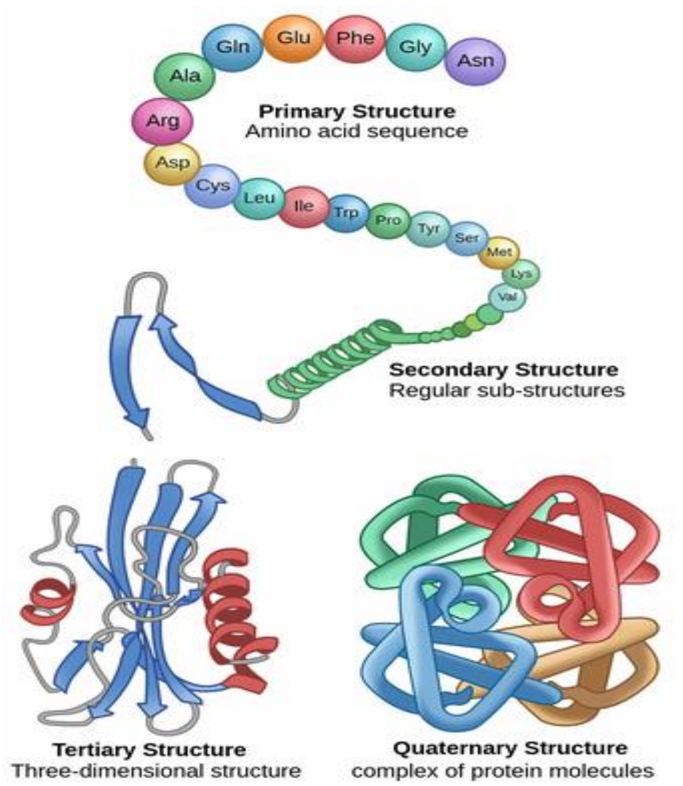
When two or more polypeptide chains are held together by disulfide bridges, salt bridges, hydrogen bond, or hydrophobic interactions, forming a larger protein complex such as insulin.

- Each of the polypeptide subunits has its own primary, secondary, and tertiary structure.
- The arrangement of the subunits to form a larger protein is the quaternary structure of the protein.
- Hemoglobin contains four chains, the heme group in each subunit picks up oxygen in the blood for transport to the tissues



Summary of Structural Levels of protein

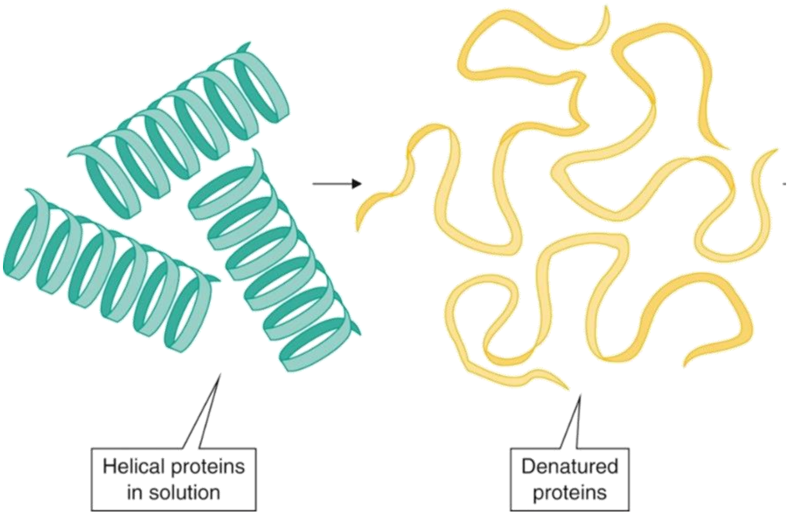




Denaturation of protein

In the normal state, Proteins are maintained in their **native state** (their natural 3D conformation) by stable secondary and tertiary structures, and by aggregation of subunits into quaternary structures.

Denaturation is caused when the folded native structures break down because of the exposure of protein to one of the denaturing agents, which disrupts the stabilizing structures. The structure becomes random and disorganized. In this case, the protein loses its biological activity with loss of structure.

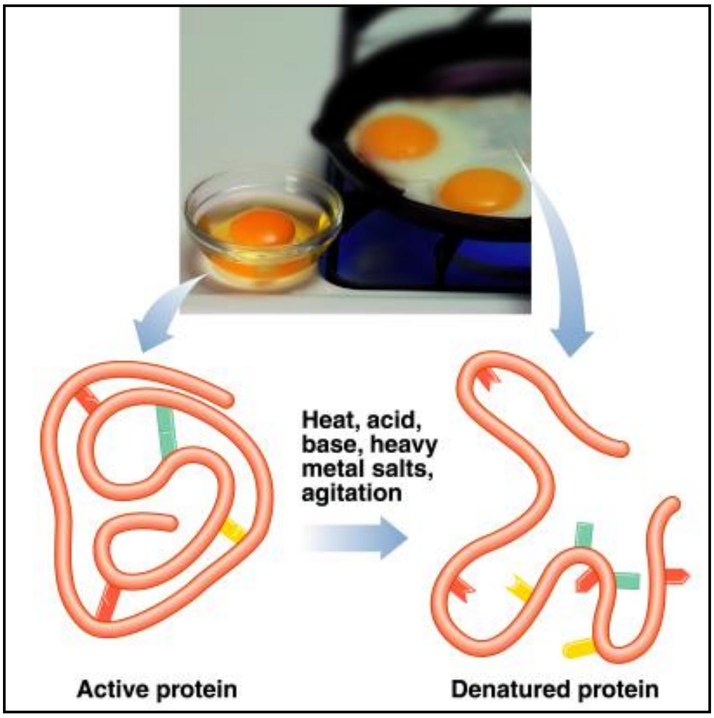


Substances that Denature Proteins (denaturing agents)

- Heat and ultraviolet light
- Organic solvents (ethanol and others miscible with water)
- Strong acids or bases
- Detergents
- Heavy-metal ions (Hg^{2+}, Ag^{+}, and Pb^{2+})
- mechanical mixing
- UV or nuclear radiation

Applications of Denaturation

- Cooking food containing protein



- Wiping the skin with alcohol (denaturation of bacterial proteins)
- Hair permanents