# Macromolecules of Biological System :Proteins

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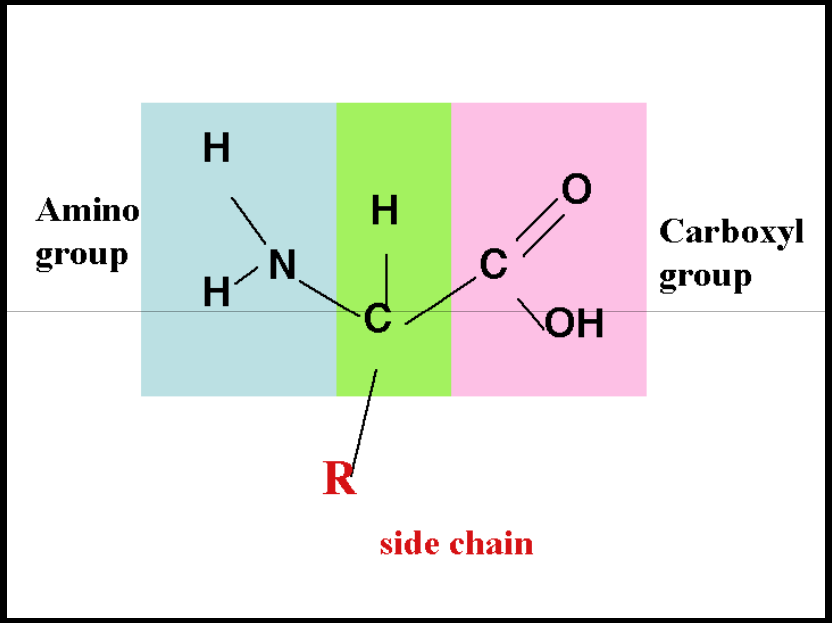
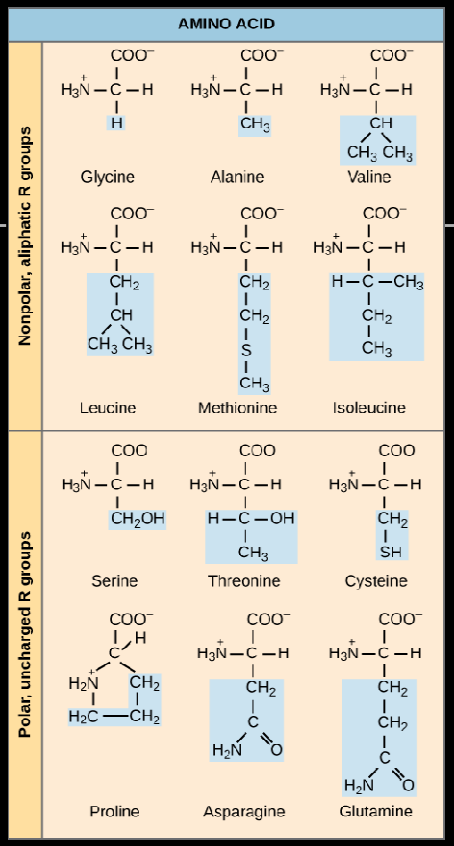
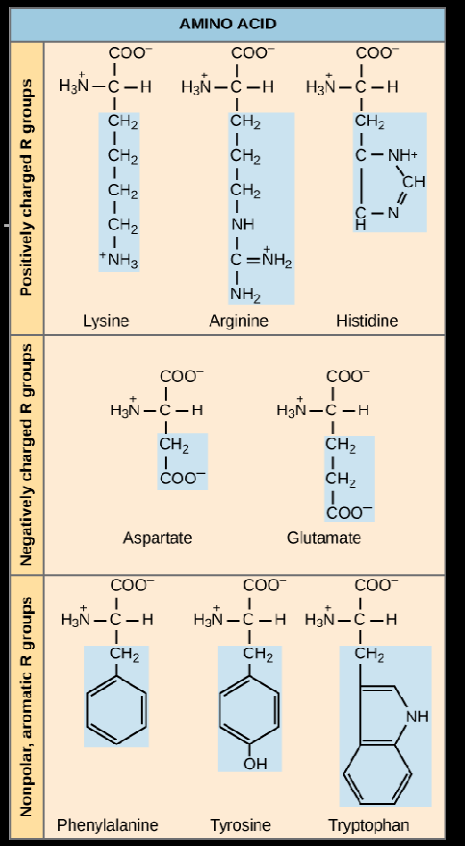
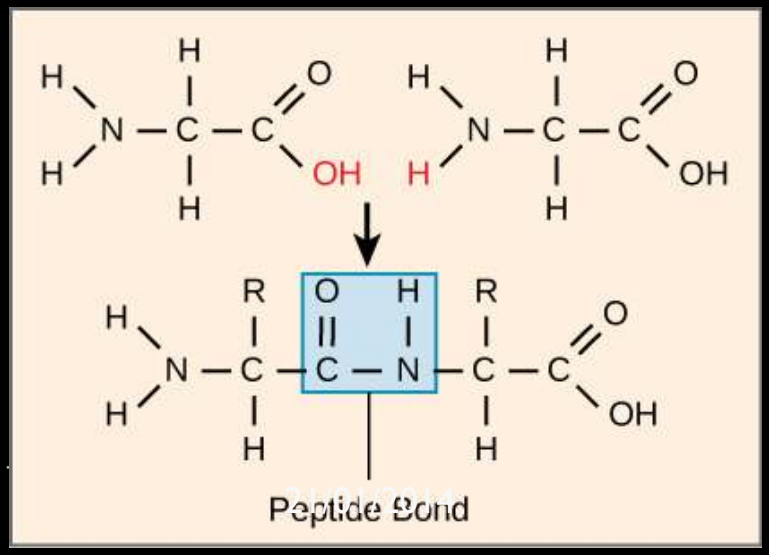
- Proteins are made of C, H, O, N and S. The building units of proteins are amino acids.
- Each amino acid contains an amino group, a carboxyl group, a central carbon and hydrogen, and an R group.
- Variation on R group defines different amino acids.



- Proteins are large biological molecules, or macromolecules, consisting of one or more chains of amino acid residues.
- A polypeptide is a single linear polymer chain derived from the condensation of amino acids. The individual amino acid residues are bonded together by peptide bonds and adjacent amino acid residues.



- Proteins perform a vast array of functions within living organisms, including catalyzing metabolic reactions, replicating DNA, responding to stimuli, and transporting molecules from one location to another.

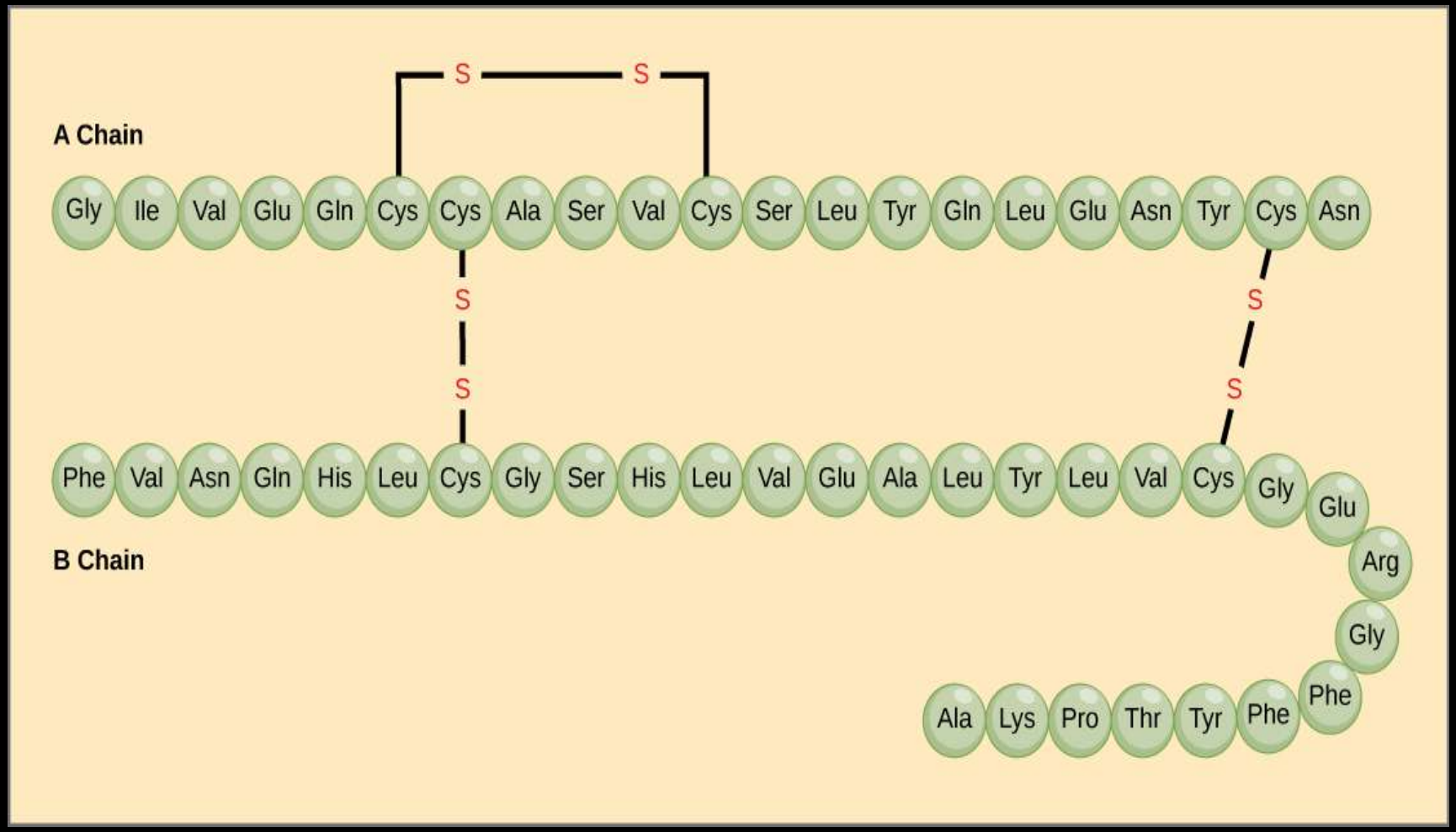
| Protein Types and Functions | | |
|---|---|---|
| **Type** | **Examples** | **Functions** |
| Digestive Enzymes | Amylase, lipase, pepsin, trypsin | Help in digestion of food by catabolizing nutrients into monomeric units |
| Transport | Hemoglobin, albumin | Carry substances in the blood or lymph throughout the body |
| Structural | Actin, tubulin, keratin | Construct different structures, like the cytoskeleton |
| Hormones | Insulin, thyroxine | Coordinate the activity of different body systems |
| Defense | Immunoglobulins | Protect the body from foreign pathogens |
| Contractile | Actin, myosin | Effect muscle contraction |
| Storage | Legume storage proteins, egg white (albumin) | Provide nourishment in early development of the embryo and the seedling |

## Protein types

| Type | Function | Examples |
|---|---|---|
| Structural | Give shape and structure to cell or organelles | Actin<br>Tubulin |
| Enzymes | Catalyse biological reactions | Trypsin<br>Adenylate cyclase |
| Receptors | Bind to other molecules and transmit signal | Glutamate R.<br>Steroid R. |
| Other functional proteins | Have specific functions | Antibodies<br>Nuclear factors<br>Neuropeptides |

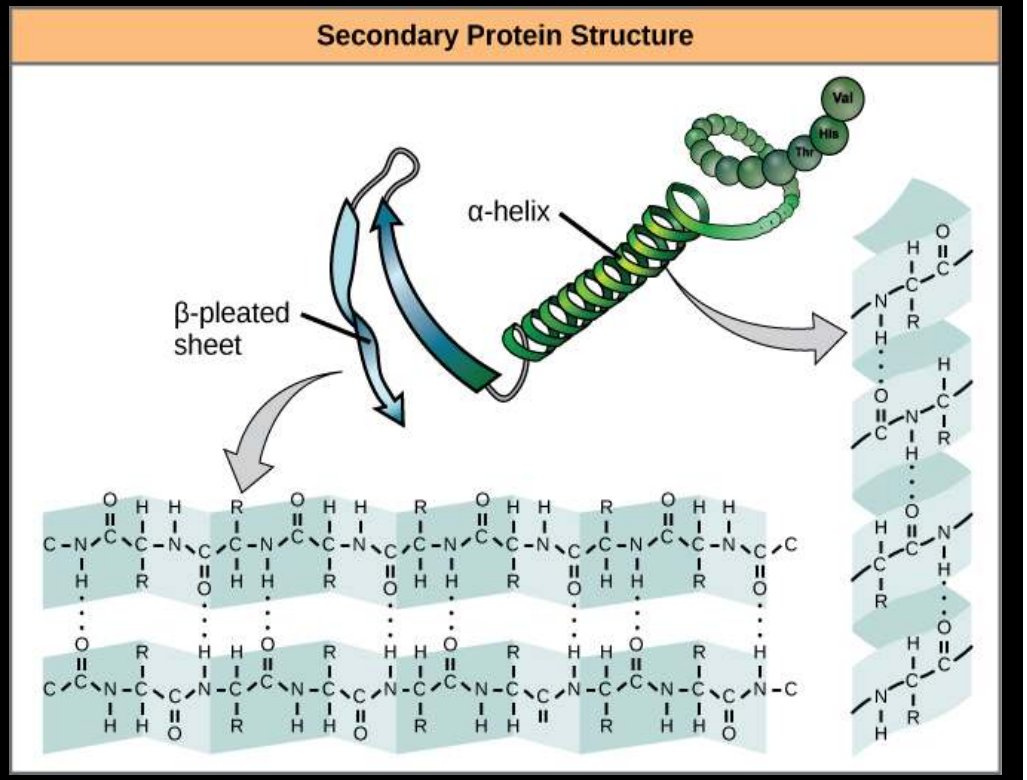
# Primary structure

- The unique sequence of amino acids in a polypeptide chain is its primary structure.
- For example, the pancreatic hormone insulin has two polypeptide chains, A and B, and they are linked together by disulfide bonds.
- The N terminal amino acid of the A chain is glycine, whereas the C terminal amino acid is asparagine.
- The sequences of amino acids in the A and B chains are unique to insulin.


S
S
A Chain
Gly Ile Val Glu Gln Cys Cys Ala Ser Val Cys Ser Leu Tyr Gln Leu Glu Asn Tyr Cys Asn
S
S
S
S
Phe Val Asn Gln His Leu Cys Gly Ser His Leu Val Glu Ala Leu Tyr Leu Val Cys Gly Glu
Arg
Gly
Phe
Ala Lys Pro Thr Tyr Phe
B Chain

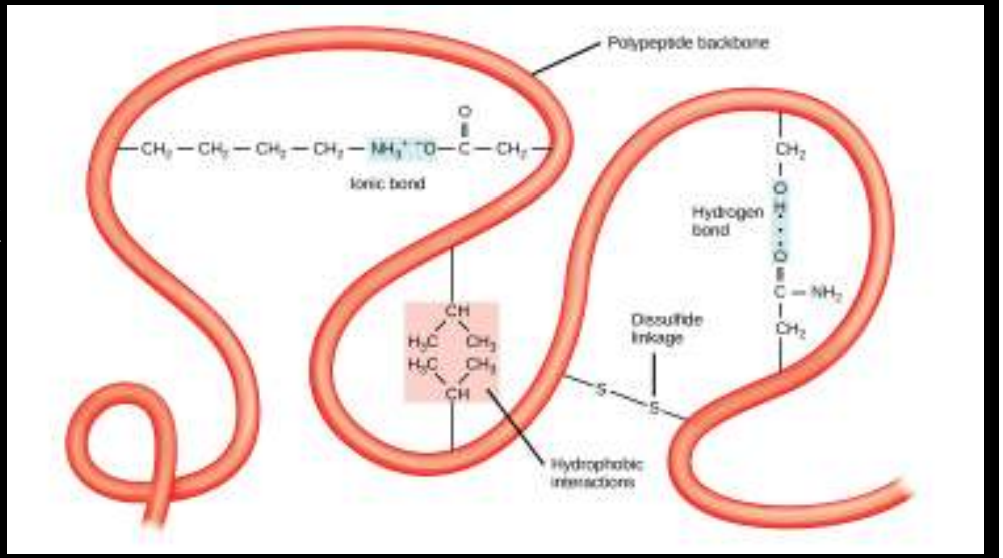
# Secondary structure

- The local folding of the polypeptide in some regions gives rise to the secondary structure of the protein.
- The most common are the α-helix and β-pleated sheet structures. Both structures are the α-helix structure—the helix held in shape by hydrogen bonds.



# Tertiary structure

- The unique three-dimensional structure of a polypeptide is its tertiary structure.
- the interactions among R groups creates the complex three-dimensional tertiary structure of a protein.
- These include hydrophobic interactions, ionic bonding, hydrogen bonding and disulfide linkages.

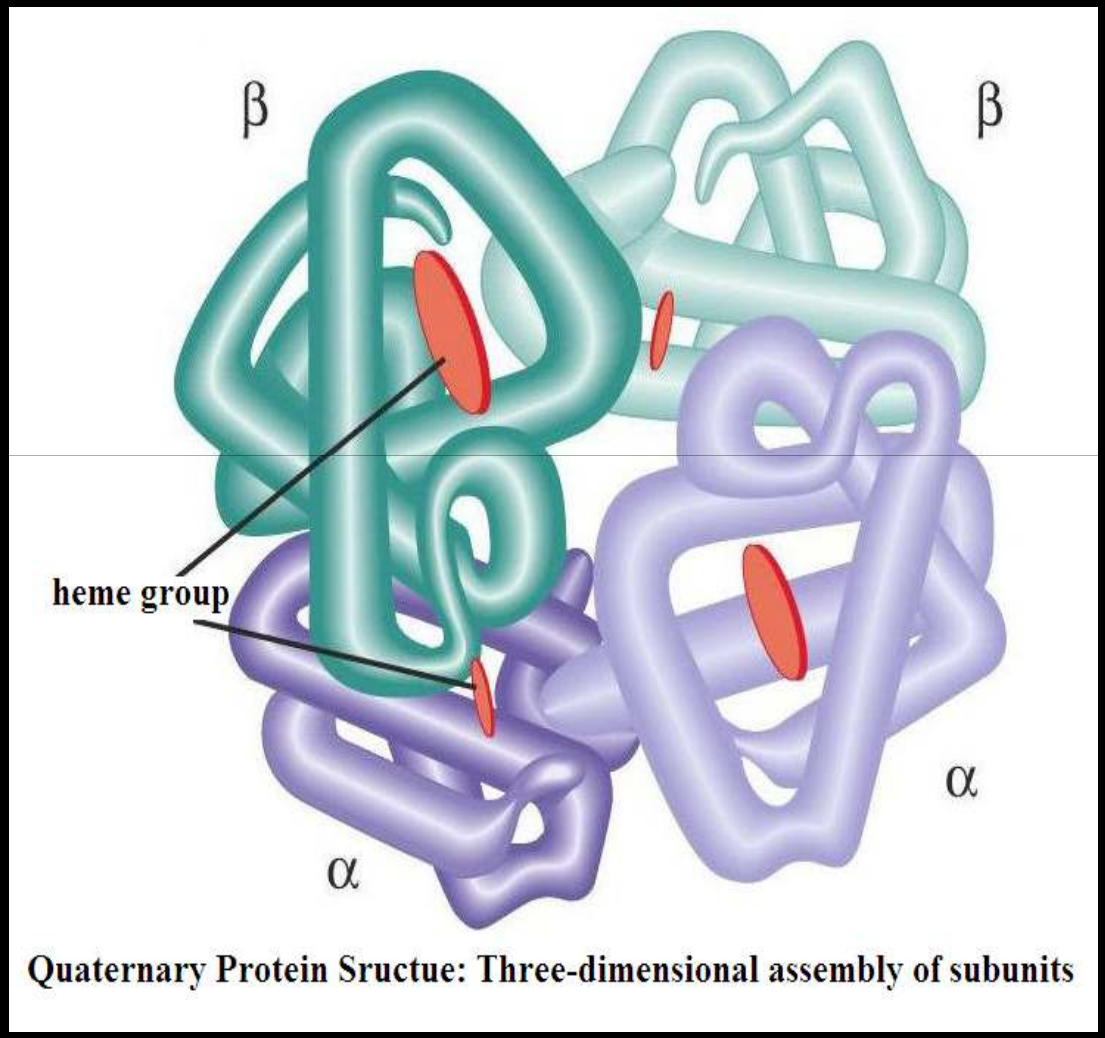


# Quaternary structure

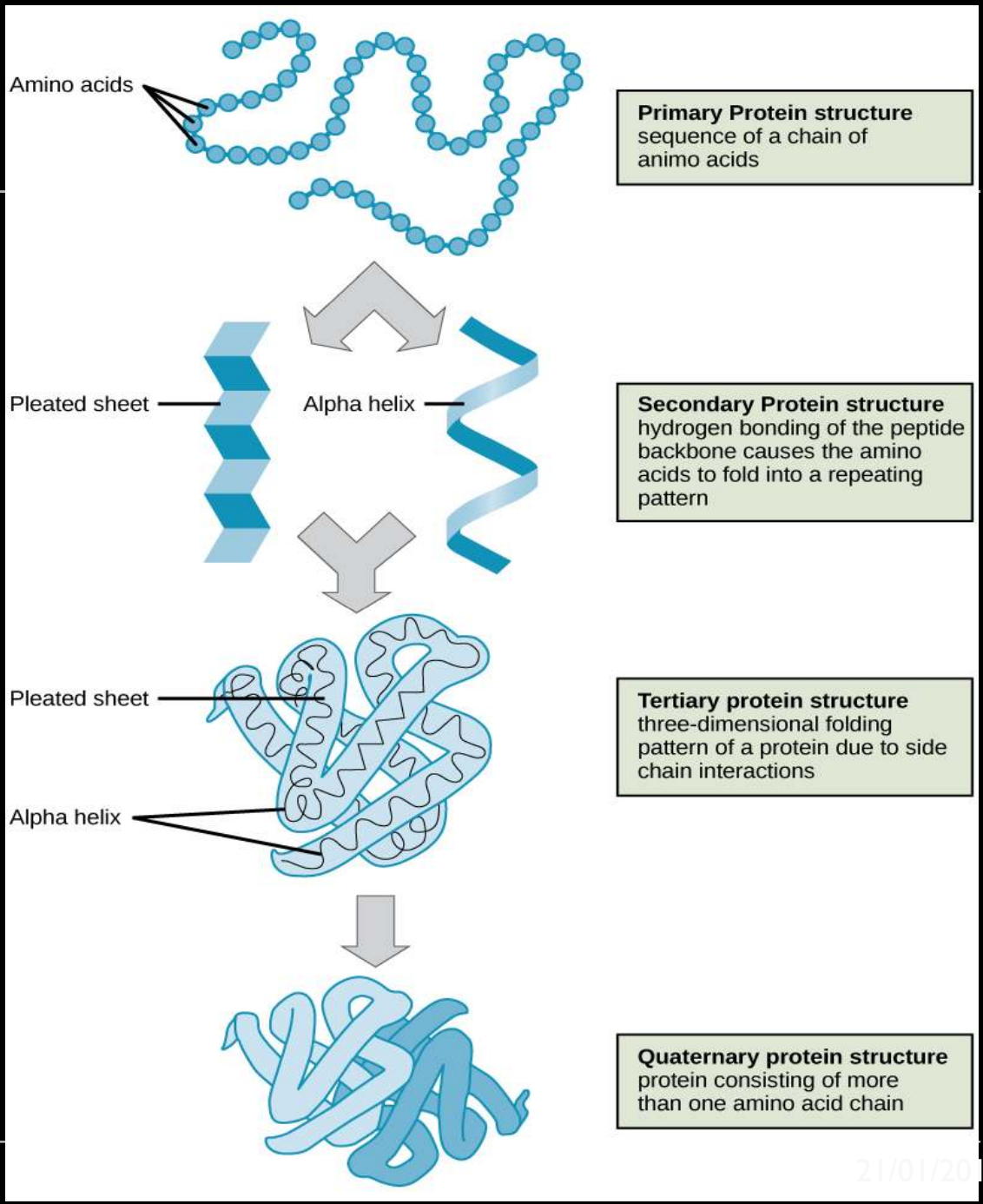
- Many proteins are actually assemblies of more than one polypeptide chain, which in the context of the larger assemblage are known as protein subunits.
- In addition to the tertiary structure of the subunits, multiple-subunit proteins assemble to form a quaternary structure.
- Enzymes composed of subunits with diverse functions are sometimes called holoenzymes, in which some parts may be known as regulatory subunits and the functional core is known as the catalytic subunit.
- Examples of proteins with quaternary structure include hemoglobin, DNA polymerase, and ion channels.

# Haemoglobin

- Hemoglobin also spelled haemoglobin and abbreviated Hb or Hgb, is the iron-containing oxygen-transport metalloprotein in the red blood cells of all vertebrates. Hemoglobin in the blood carries oxygen from the respiratory organs (lungs or gills) to the rest of the body (i.e. the tissues) where it releases the oxygen to burn nutrients to provide energy to power the functions of the organism in the process called metabolism.
- Hemoglobin has a quaternary structure characteristic of many multi-subunit globular proteins. Most of the amino acids in hemoglobin form alpha helices, connected by short non-helical segments.




Quaternary Protein Sructue: Three-dimensional assembly of subunits


Amino acids
Pleated sheet
Alpha helix
Pleated sheet
Alpha helix
Primary Protein structure
sequence of a chain of animo acids
Secondary Protein structure
hydrogen bonding of the peptide backbone causes the amino acids to fold into a repeating pattern
Tertiary protein structure
three-dimensional folding pattern of a protein due to side chain interactions
Quaternary protein structure
protein consisting of more than one amino acid chain

# Functions of Proteins

- Proteins are the basis of protoplasm and hence they occur in all living organisms. Some of the different forms of proteins and their important functions are given below:
- 1. Proteins as muscle, skin, hair, and other tissues constitute the bulk of body's non-skeletal structure. For example, the protein keratin is present in hair and nails.
- 2. Some proteins as hormones regulate many body functions. For example, the hormone insulin is a protein. It regulates sugar level in the blood.
- 3. Some proteins as enzymes catalyse or help in biochemical reactions. For example, pepsin and tripsin.

- 4. Some proteins act as antibodies, and protect the body from the effect of invading species or substances.
- 5. Transport proteins carry different substances in the blood of different tissues. For example, haemoglobin is a transport protein. It carries oxygen from lungs to the tissues and carbon dioxide from tissues to the lungs.
- 6. Contractile proteins help in contraction of muscle and other cells of our body. Myosin is an example of contractile protein.


Thank you