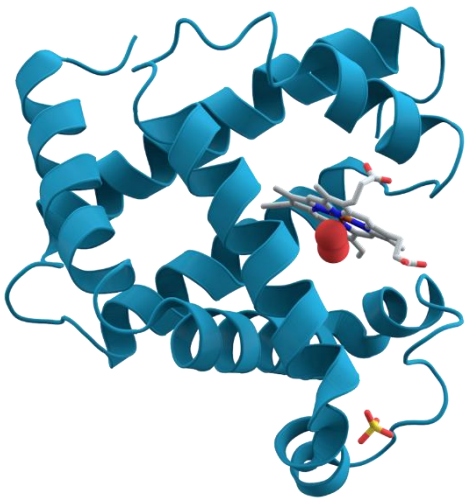
Proteins

Proteins

What are Proteins?

- Proteins are large, complex molecules that are essential for all living organisms.
- They do most of the work inside cells and are often called the building blocks of life because they are required for the structure, function, and regulation of the body's tissues and organs.
- Every cell in the body contains proteins.



Structure of Proteins

- Proteins are made of smaller units called amino acids, which are linked together in long chains.
- The number, order, and arrangement of amino acids — and how the chain folds — determine the structure and function of each protein.

A helpful way to think about this is:

- A protein is like a necklace.
- Amino acids are the beads.
- The way the beads are arranged and folded gives the protein its final shape and job.

Proteins are involved in:

- building and repairing tissues,
- transporting substances (for example, oxygen),
- speeding up chemical reactions (as enzymes),
- acting as hormones (chemical messengers),
- and defending the body (as antibodies).

Amino Acids

What are Amino Acids?

- Amino acids are the basic building blocks of proteins.
- There are 20 standard amino acids found in living organisms.

Each amino acid has the same basic structure:

- a central carbon atom (C),

- an amino group ($–NH_2$),
- a carboxyl group (–COOH),
- a hydrogen atom (H),
- and a side chain (R group).
- The R group is different for each amino acid and is what makes every amino acid unique.
- It determines whether the amino acid is acidic, basic, polar, or non-polar.
- The R group can be very simple (such as a single hydrogen) or more complex (such as a ring structure).

How are Proteins Made from Amino Acids?

- Amino acids join together through a special chemical bond called a peptide bond.
- The carboxyl group of one amino acid links to the amino group of the next.
- Repeating this process forms a long chain called a polypeptide.
- When a polypeptide folds into a specific three-dimensional shape, it becomes a functional protein.

Types of Amino Acids

- Essential amino acids – must be obtained from food because the body cannot make them.
- Non-essential amino acids – can be made by the body.

Key Terms

- Amino acid – the basic building unit of proteins.
- Peptide bond – the bond that links amino acids together.
- Polypeptide – a chain of amino acids.
- Protein – one or more folded polypeptide chains that perform a specific function.

Protein Structure

Protein Structure

- Proteins don't work unless they are in the right shape.
- The shape of a protein determines its function.
- The shape depends on how the amino acids are arranged and folded.

There are four levels of protein structure:

1. Primary Structure

- This is the sequence of amino acids in a protein.

- It's like the order of letters in a word or beads in a necklace.
- Even one change in this sequence can lead to a non-functioning or harmful protein (e.g., sickle cell disease).

2. Secondary Structure

- Local folding of the amino acid chain into α-helix (alpha helix) or β-pleated sheet (beta sheet).
- These shapes are held together by hydrogen bonds.
- Think of the alpha helix like a coiled spring and the beta sheet like folded paper.

3. Tertiary Structure

- This is the overall 3D shape of a single polypeptide chain.
- It includes all the bends and twists in the chain.
- It's stabilized by different bonds like hydrogen bonds, disulfide bonds, ionic bonds, and hydrophobic interactions.

4. Quaternary Structure

- Some proteins are made up of more than one polypeptide chain.
- The quaternary structure is the arrangement of these multiple chains.
- **Example**: Hemoglobin, which has four polypeptide chains working together.

Denaturation

- When the structure is lost due to heat or chemicals, the protein is said to be denatured, and it may lose its function permanently.

Why is Protein Structure Important?

- The structure determines the function of the protein.
- If the shape is wrong (due to mutation, heat, or pH changes), the protein may not work properly or may become harmful.
- This is called denaturation, and it usually destroys the protein's function.

Regularities in Cell Signaling (Signal Transduction Pathways)

- Protein signaling pathways are series of interactions where one protein activates the next—much like a domino effect.
- They control processes such as:
  - growth,
  - cell division,
  - movement,

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