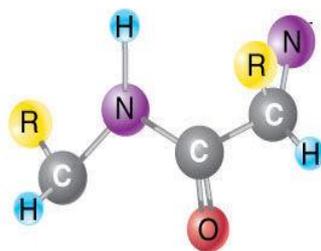
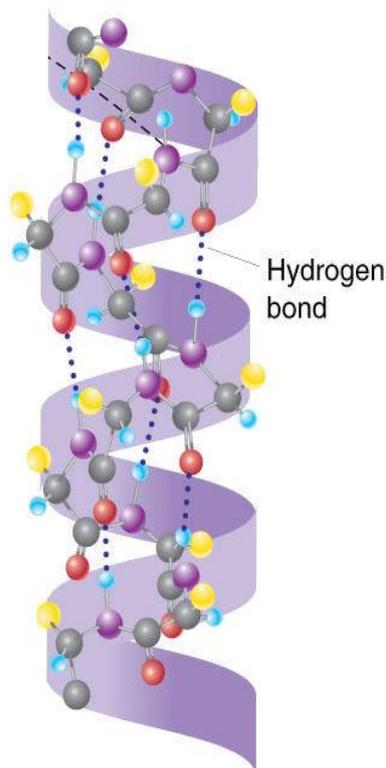


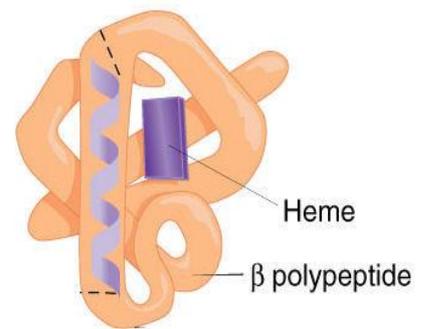
Structures of Proteins



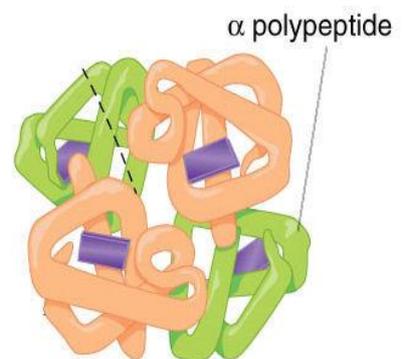
(a) Primary structure



(b) Secondary structure



(c) Tertiary structure



(d) Quaternary structure

Background:

Proteins, the most abundant organic molecules in cells are found in every part of every cell, because they are fundamental in all aspects of cell structure and function. Although plants can synthesize proteins from simple inorganic substances found both in soil and in the air, animals, including man, require certain organic substances in the diet to meet their protein requirements.

Chemical composition of proteins:

All proteins contain the elements carbon, hydrogen, oxygen, and nitrogen. The presence of nitrogen in proteins makes them different from other biomolecules such as carbohydrates and lipids. In addition to these elements individual proteins may contain sulfur, phosphorus, selenium, iron, iodine, copper and other elements.

Chemical structure of proteins :

- a. **Structurally**, all proteins are condensation polymers of amino acids (figure1).
 - Although over 40 different amino acids have been found in proteins only about 20 are relatively common.
 - These amino acids are linked together by peptide bonds into long chains from 50 to several thousand amino acids.
 - The specific number of amino acids and the sequence in which they are joined together, twisted, folded and crosslinked make possible the many different proteins, with their diverse functions, present in a multitude of organisms.

- b. **Amino acids** are organic acids that contain an amino group, $-NH_2$, as well as a carboxyl group, $-COOH$. The peptide linkage is the bond that joins the amino group of one amino acid to the carboxyl group of

another in a protein molecule. See (figure1)for an illustration of an amino acid and a peptide linkage.

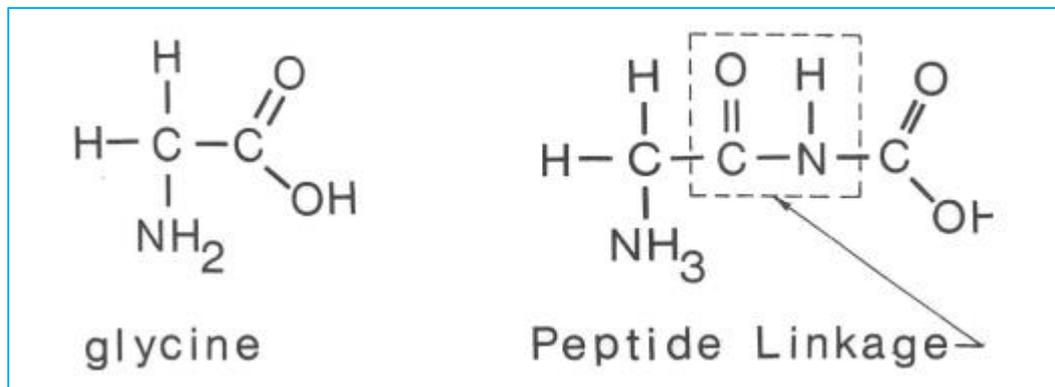


Figure-1. An amino acid and a peptide

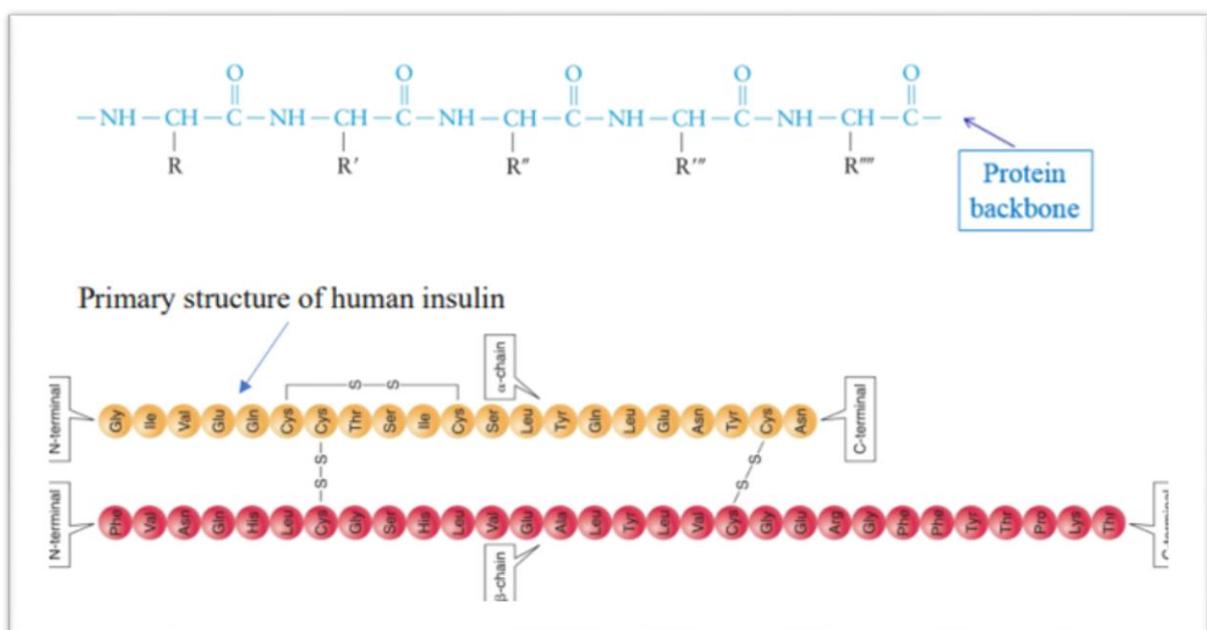
What are the levels of protein structure?

The amino acid sequence of a protein determines its three-dimensional shape.

The structure of a protein can be described in several levels.

1- primary structure

The linear sequence of residues (amino acids) in a polypeptide chain.



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

2- Secondary structure

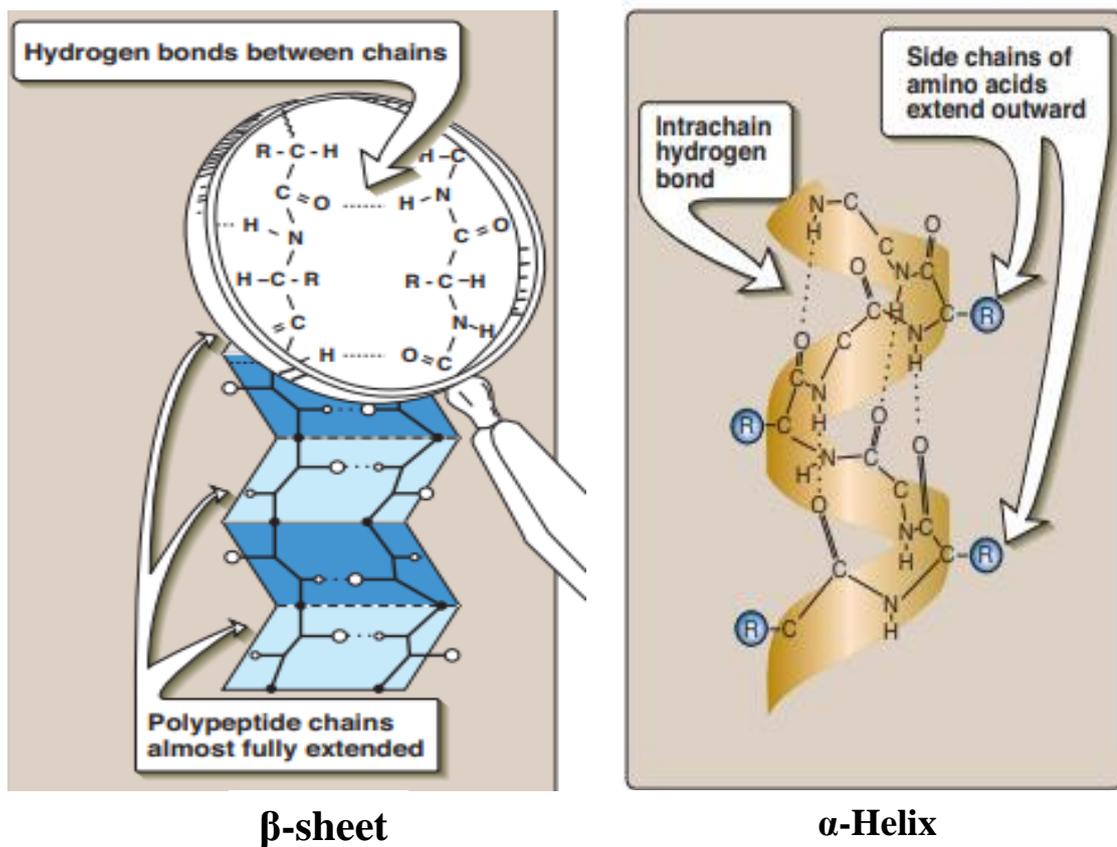
The secondary structure the arrangement of a polypeptide chain into more or less regular hydrogen-bonded structures -- has two basic elements –

a: α -helix :

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:

The β -sheet is another form of secondary structure in which all of the peptide bond components are involved in hydrogen bonding.The surfaces of β -sheets appear “pleated,” and these structures are, therefore, often called “ β -pleated sheets.”



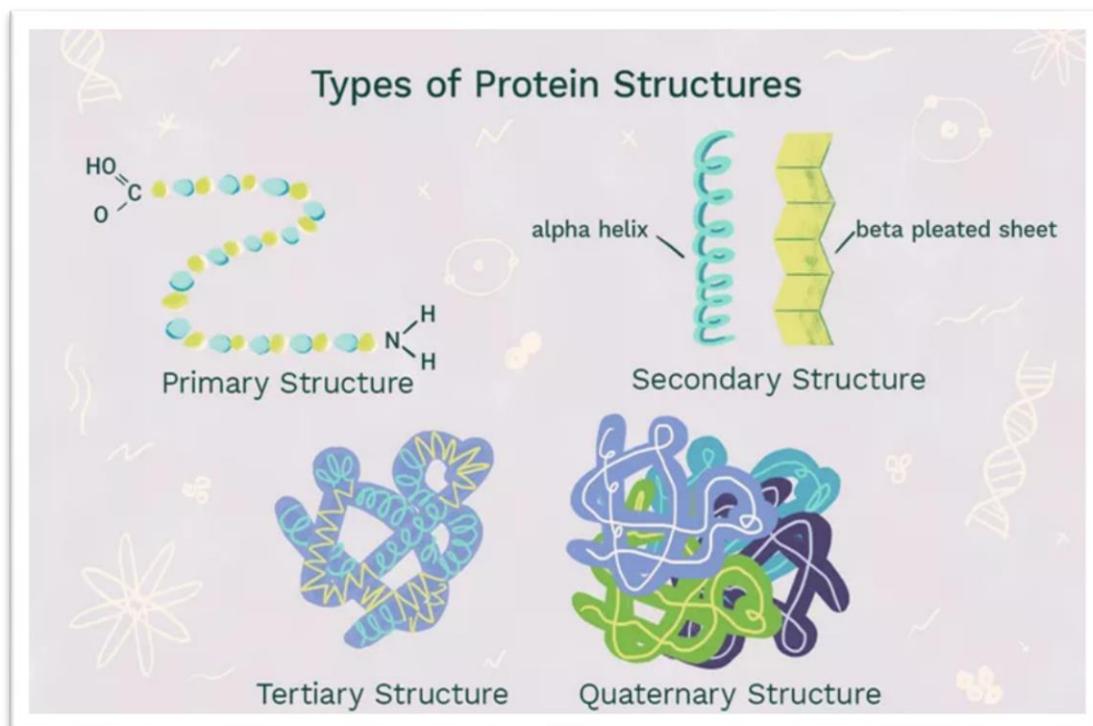
The α -helix and β -sheet structures provide maximal hydrogen bonding for peptide bond components within the interior of polypeptides

3-Tertiary structure of globular proteins :

The level of protein structure at which an entire polypeptide chain has folded into a three-dimensional structure. In multi-chain proteins, the term tertiary structure applies to the individual chains.

4. Quaternary structure of proteins :

The fourth order of complexity of structural organization exhibited by protein molecules, and refers to the arrangement in space of the complete protein, without regard to the internal geometry of the subunits. Quaternary structure is possessed only when the molecule is made of at least two subunits that are separable..



Protein folding:

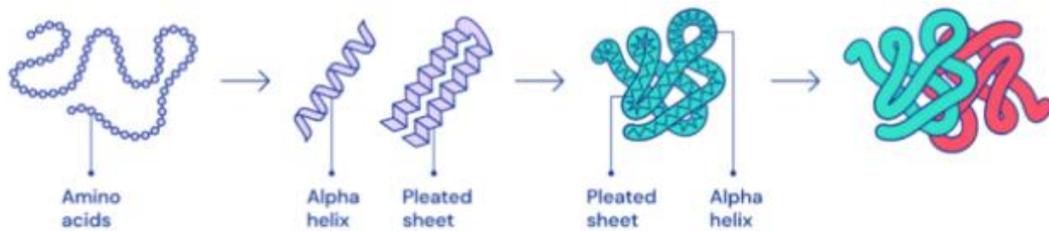
Protein folding is the physical process, typically a "folded" conformation by which the protein becomes biologically functional. **Protein folding** interactions between the side chains of amino acids determine how along polypeptide chain folds into the intricate three-dimensional shape of the functional protein. Protein folding, which occurs within the cell in seconds to minutes, employs a shortcut through the maze

of all folding possibilities. As a peptide folds, its amino acid side chains are attracted and repulsed according to their chemical properties.

Steps in protein folding:

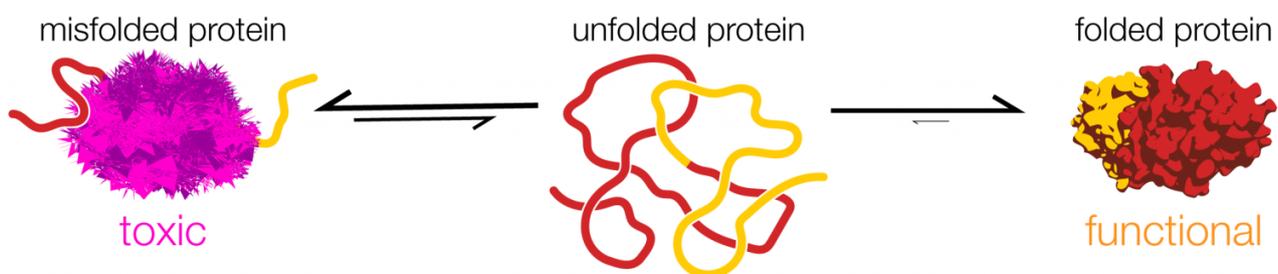
Folding basically takes place in 4 steps:

- In the first step, the protein is a straight chain of amino acids.
- In the second step the chain creates alpha helixes and beta layer structures
- In other steps, the protein becomes more and more organized. It can be thought of as creating words from letters, sentences and paragraphs from words.



❖ Protein misfolded:

- ✓ Protein folding is a complex, trial-and-error process that can sometimes result in improperly folded molecules.
- ✓ These misfolded proteins are usually tagged and degraded within the cell.
- ✓ Deposits of these misfolded proteins are associated with a number of diseases such as Amyloid disease Prion disease.



❖ Protein denaturation :

Protein denaturation results in the unfolding and disorganization of the protein's structure, which are not accompanied by hydrolysis of peptide bonds.

