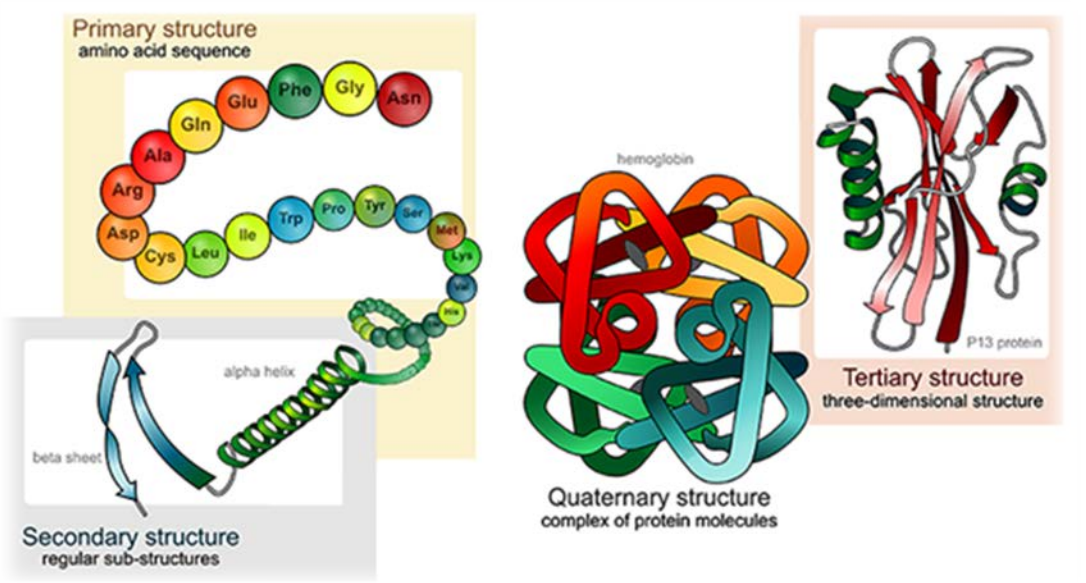
BIOCHEMISTRY - YEAR 2



Protein structure

Lecture No: 6

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Objectives

At the end of this lecture we will understand the following points.

- Protein structure
  - Primary structure
  - Secondary structure
  - Tertiary structure
  - Quaternary structure
- Denaturation

Protein structure

- There are four levels of protein structure (primary, secondary, tertiary and quaternary)
- Protein structure depends on its amino acid sequence and local, low-energy chemical bonds between atoms in both the polypeptide backbone and in amino acid side chains.
- Protein structure plays a key role in its function; if a protein loses its shape at any structural level, it may no longer be functional.

Protein structure

- Primary structure is the amino acid sequence.
- Secondary structure is local interactions between stretches of a polypeptide chain and includes α-helix and β-pleated sheet structures.
- Tertiary structure is the overall the three-dimension folding driven largely by interactions between R groups.
- Quarternary structures is the orientation and arrangement of subunits in a multi-subunit protein.

Primary structure

- Primary structure is simply the sequence of amino acids in a polypeptide chain. At one end is an amino acid with a free amino group the (the N-terminus) and at the other is an amino acid with a free carboxyl group the (the C-terminus).
- The primary structure of a protein is its unique sequence of amino acids.
- The precise primary structure of a protein is determined by inherited genetic information.

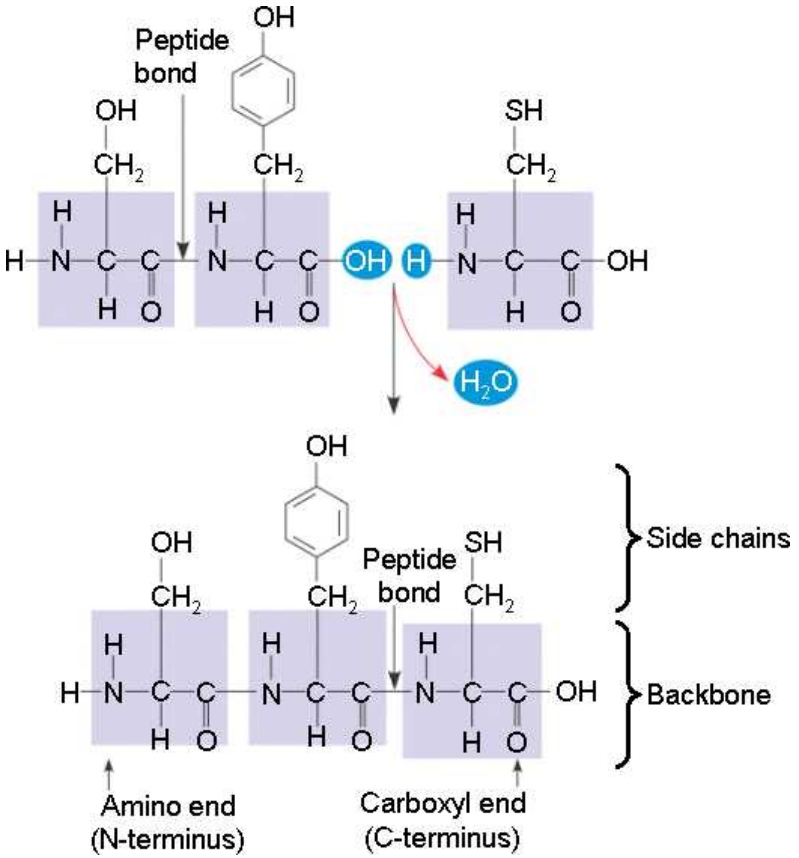


Image drawn by http://bio1151.nicerweb.com/Locked/media/ch05/peptide.html

Secondary structure

Results from hydrogen bond formation between hydrogen of –NH group of peptide bond and the carbonyl oxygen of another peptide bond. According to H-bonding there are two main forms of secondary structure:

α-helix: It is a spiral structure resulting from hydrogen bonding between one peptide bond and the fourth one.

β-sheets: is another form of secondary structure in which two or more polypeptides (or segments of the same peptide chain) are linked together by hydrogen bond between H- of NH- of one chain and carbonyl oxygen of adjacent chain (or segment).

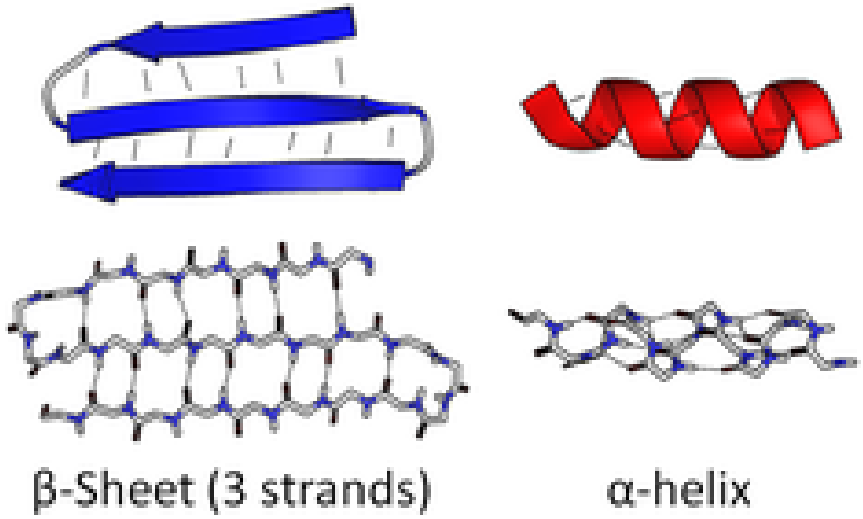


Image drawn by BYU-I student Nate Shoemaker Spring 2016

Tertiary structure

•Is determined by a variety of interactions (bond formation) among R groups and between R groups and the polypeptide backbone.

a. The weak interactions include:

•Hydrogen bonds among polar side chains.

•Ionic bonds between charged R groups

(basic and acidic amino acids)

•Hydrophobic interactions among

hydrophobic (non polar) R groups.

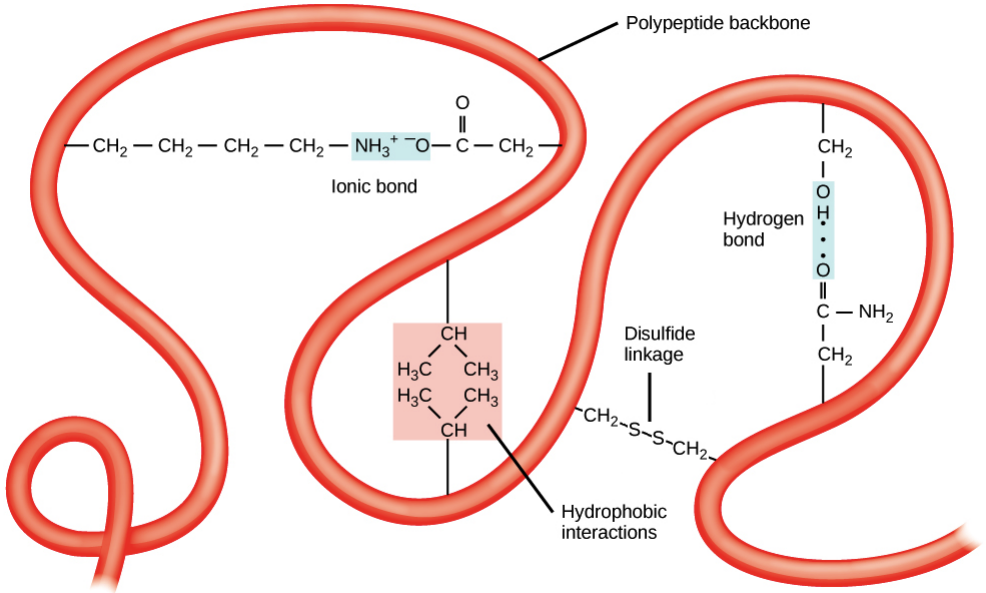


Image modified from OpenStax Biology.

Quaternary structure

- Many proteins are made up of a single polypeptide chain and have only three levels of structure (the ones we've just discussed). However, some proteins are made up of multiple polypeptide chains, also known as subunits. When these subunits come together, they give the protein its **quaternary structure**.

- Results from the aggregation (combination) of two or more polypeptide subunits held together by non-covalent interaction like H-bonds, ionic or hydrophobic interactions.

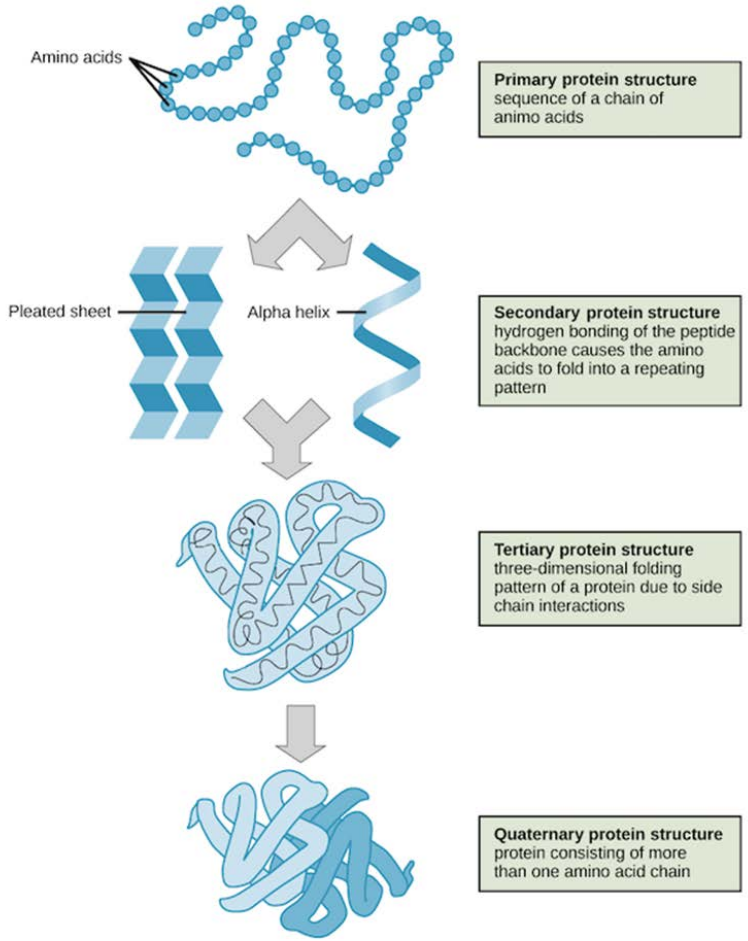


Image modified from OpenStax Biology's modification of work by the National Human Genome Research Institute.

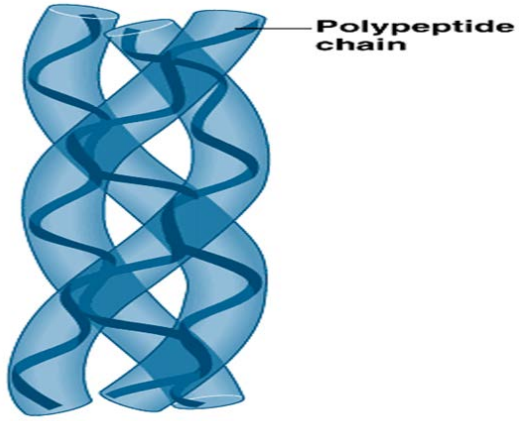
Quaternary structure

- Examples on protein having quaternary structure:
  - Collagen is a fibrous protein of three polypeptides (trimeric) that are supercoiled like a rope.

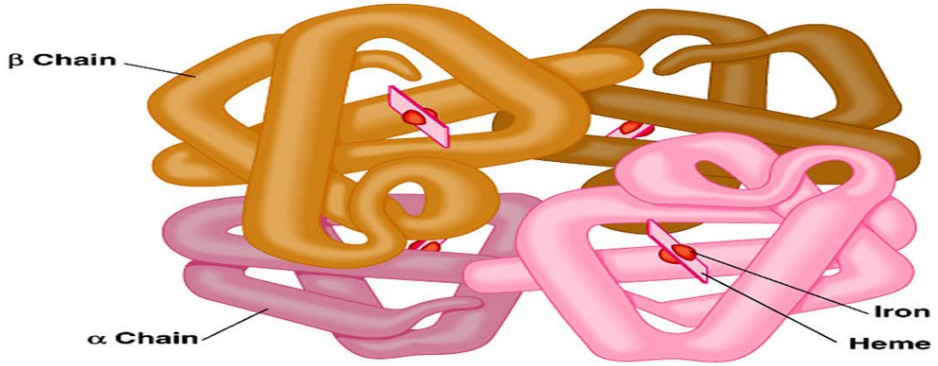
- This provides the structural strength for their role in connective tissue.

  - Hemoglobin is a globular protein with four polypeptide chains (tetrameric)

  - Insulin : two polypeptide chains (dimeric).



(a) Collagen



(b) Hemoglobin

Denaturation

Each protein has its own unique shape. If the temperature or pH of a protein's environment is changed, or if it is exposed to chemicals, these interactions may be disrupted, causing the protein to lose its three-dimensional structure and turn back into an unstructured string of amino acids. When a protein loses its higher-order structure, but not its primary sequence, it is said to be **denatured**.

Disruption of secondary, tertiary and quaternary protein structure by

Heat/organics : Break apart H bonds and disrupt hydrophobic attractions
Acids/ bases : Break H bonds between polar R groups and ionic bonds
Heavy metal ions : React with S-S bonds to form solids
Agitation : Stretches chains until bonds break