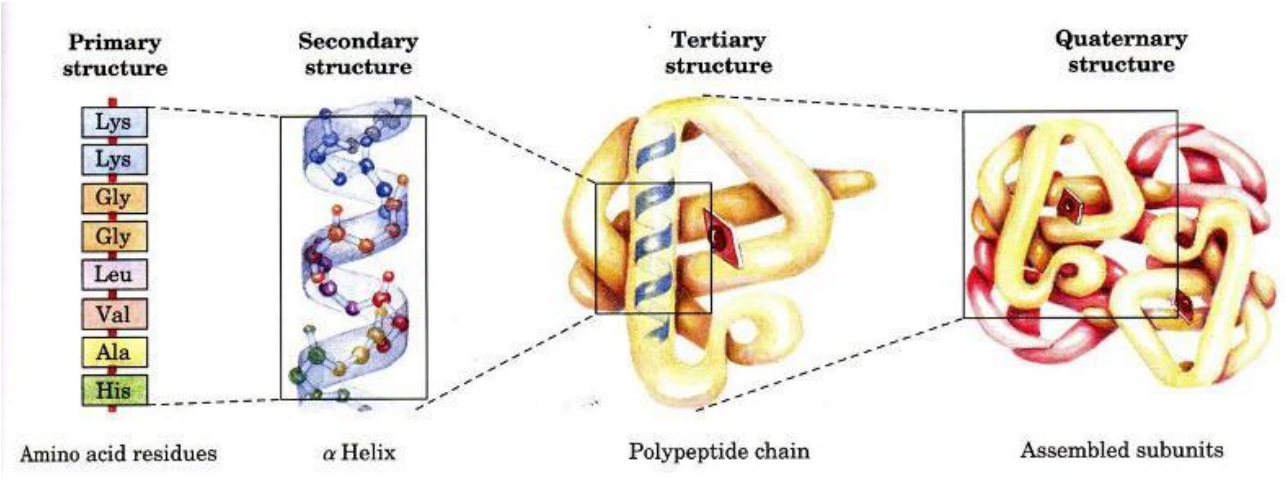
The Three-Dimensional Structure of Proteins



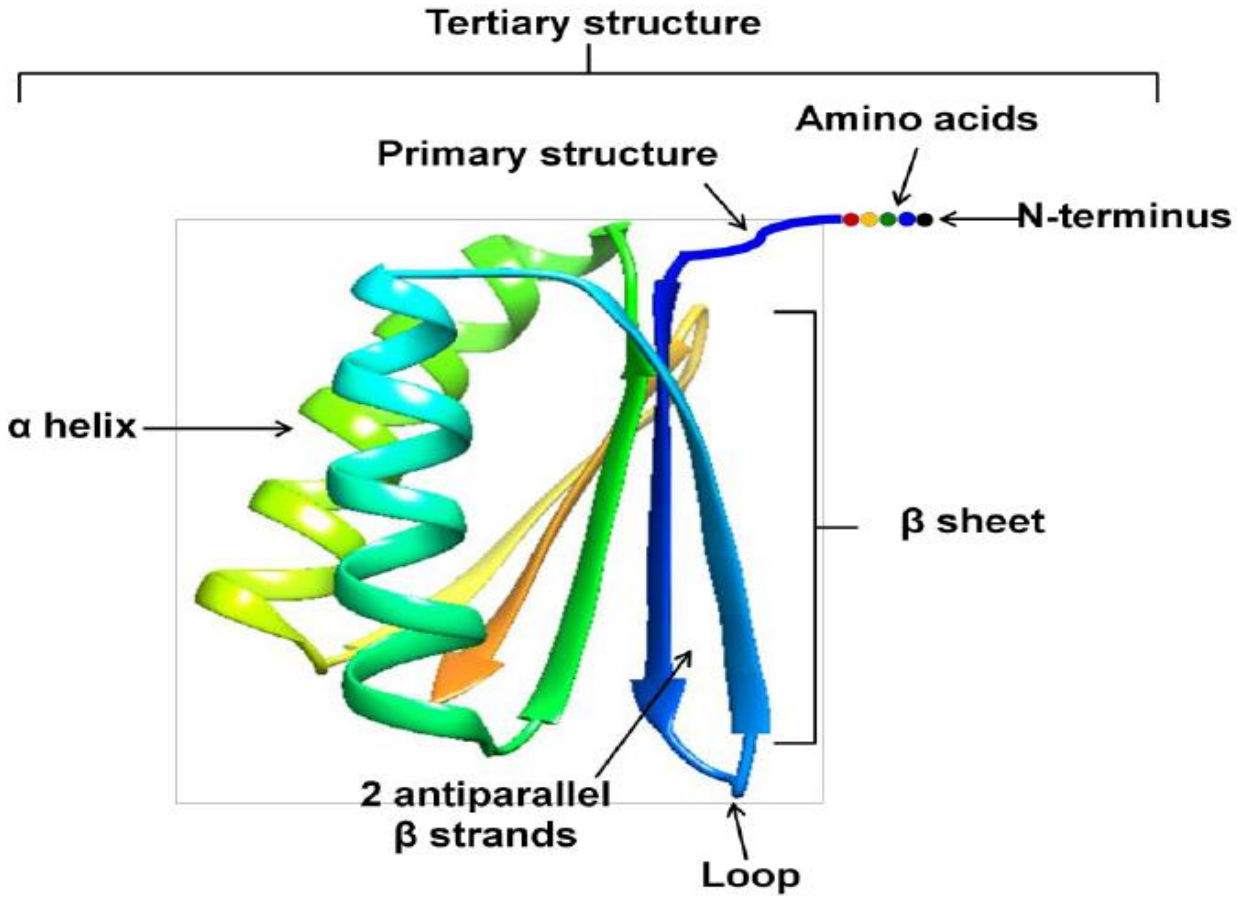
Introduction:

In geometry, a three-dimensional shape can be defined as a solid figure or an object or shape that has three dimensions—length, width, and height. Unlike two-dimensional shapes, three-dimensional shapes have height, which is the same as thickness or depth.

Protein tertiary structure is the three dimensional shape of a protein. The tertiary structure will have a single polypeptide chain "backbone" with one or more protein secondary structures, the protein domains. Amino acid side chains may interact and bond in a number of ways.

3-Dimensional Protein Structures:

Proteins are built as chains of amino acids, which then fold into unique three-dimensional shapes. Bonding within protein molecules helps stabilize their structure, and the final folded forms of proteins are well-adapted for their functions.



Classification of proteins by Structural Shape:

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

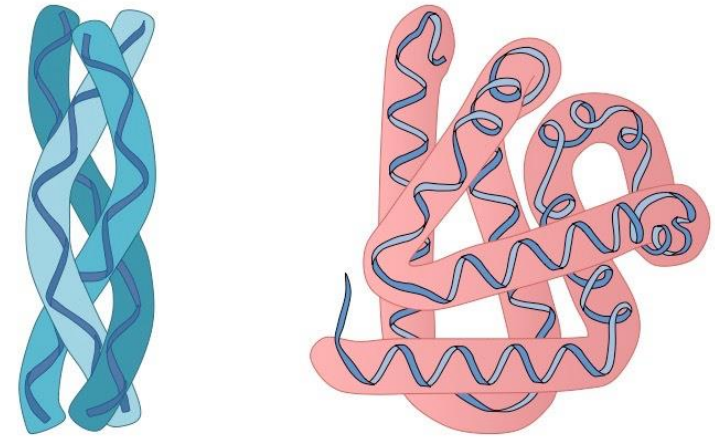
1- Fibrous proteins:

- ✓ Fibrous proteins are long strands of polypeptide chains that have cross-linkages due to hydrogen bonds
- ✓ Insoluble in water (cause by the large number of hydrophobic R groups)
- ✓ Fibrous proteins have a limited number of amino acids with the sequence usually being highly repetitive
- ✓ The highly repetitive sequence creates very organized structures that are strong and this along with their insolubility property, makes fibrous proteins very suitable for structural roles, for example, keratin that makes up hair, nails, horns and feathers and collagen which is a connective tissue found in skin, tendons and ligaments.

2-Globular proteins:

- ✓ Globular proteins are compact, roughly spherical (circular) in shape and soluble in water
- ✓ Globular proteins form a spherical shape when folding into their tertiary structure because: their non-polar hydrophobic R groups are orientated towards the center of the protein away from the aqueous surroundings and their polar hydrophilic R groups orientate themselves on the outside of the protein.
- ✓ Globular proteins are play physiological roles, for example, enzymes can catalyze specific reactions and immunoglobulin's can respond to specific antigens
- ✓ Some globular proteins are conjugated proteins that contain a prosthetic group E.g. hemoglobin which contains the prosthetic group called haem.

✓ Globular and fibrous protein models illustrating the roughly spherical shape of globular proteins and the long, stranded shape of fibrous proteins



Fibrous Protein Globular Protein

Fibrous Vs.Globular proteins

Fibrous proteins	Globular proteins
consist of parallel long fibers or large sheets	folded to more or less spherical shape
mechanically strong	All have α helices and β sheets
insoluble in water and dilute salt solutions	Soluble in water and salt solutions
play important structural roles in nature	Tertiary and quaternary structures are complex
Examples: Keratin of hair and wool, collagen etc	

How can the three-dimensional structure of a protein be determined?

The three-dimensional structure of a protein is determined by techniques such as X-ray crystallography and nuclear magnetic resonance (NMR). all the individual protein molecules have the same three-dimensional conformation and the same orientation.

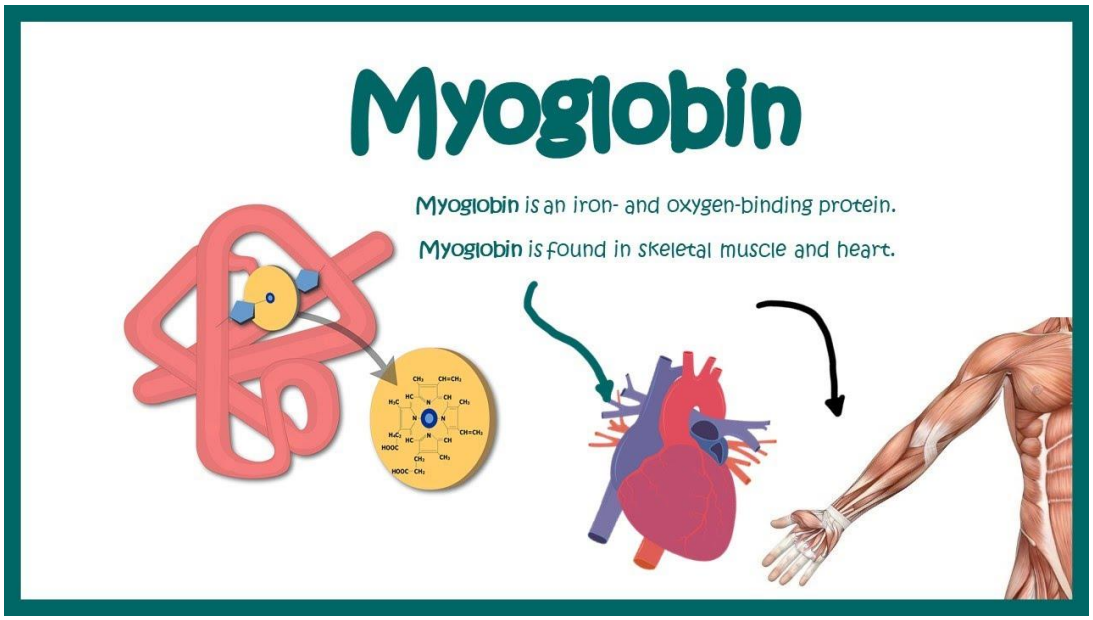
Examples of medically important proteins:

A. Collagen:

Collagen is the most abundant protein in mammals making up 25 to 35% of the total protein in the body. Collagen is a fibrous protein meaning it takes on an extended rod-like conformation. It is a key structural component of skin, tendon, and bone and contributes great strength to these tissues.

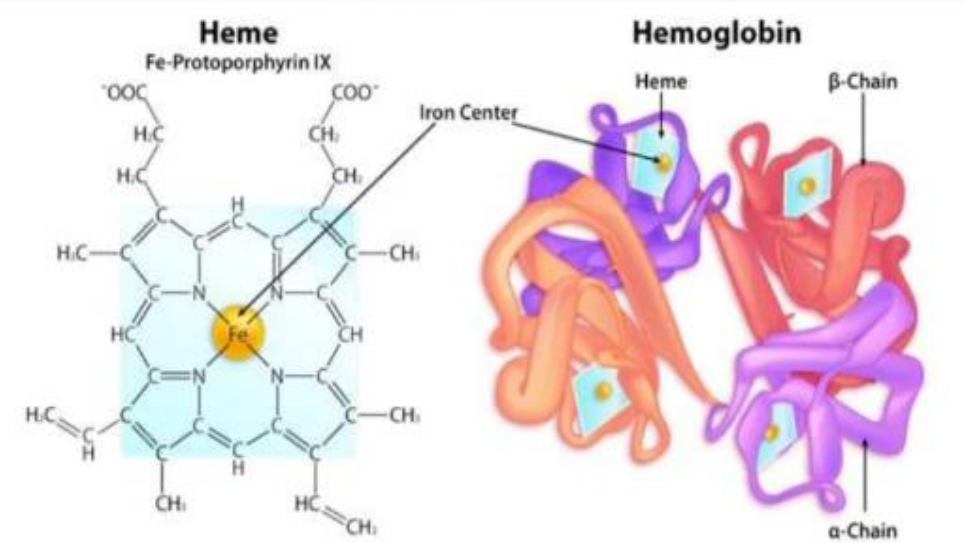
B. Myoglobin:

Myoglobin is a globular protein found in the muscles which are responsible for the storage of oxygen in the muscle cells. This stored oxygen is later used up by us while doing different activities. It is a monomeric protein made of a single type of subunit. It has a higher binding affinity than haemoglobin towards oxygen because myoglobin tends to keep oxygen in an oxidation state of +3, which stabilizes it.



C. Hemoglobin:

Haemoglobin is a globular protein found in the RBCs, which are responsible for the transport of oxygen from the lungs to the entire body. It is a tetrameric protein made up of two alpha and two beta subunits. In the quaternary structure of hemoglobin, the 4 chains are located at the corners of a tetrahedron**.**



Myoglobin Vs. Hemoglobin

Myoglobin	hemoglobin
Myoglobin is a globular protein.	hemoglobin is also a globular protein.
Water soluble.	Water soluble.
Ligand is oxygen.	Ligand is oxygen.
Myoglobin exist in muscle(tissue).	hemoglobin exist in blood.
Myoglobin is a storage protein.	Hemoglobin is a transport protein.