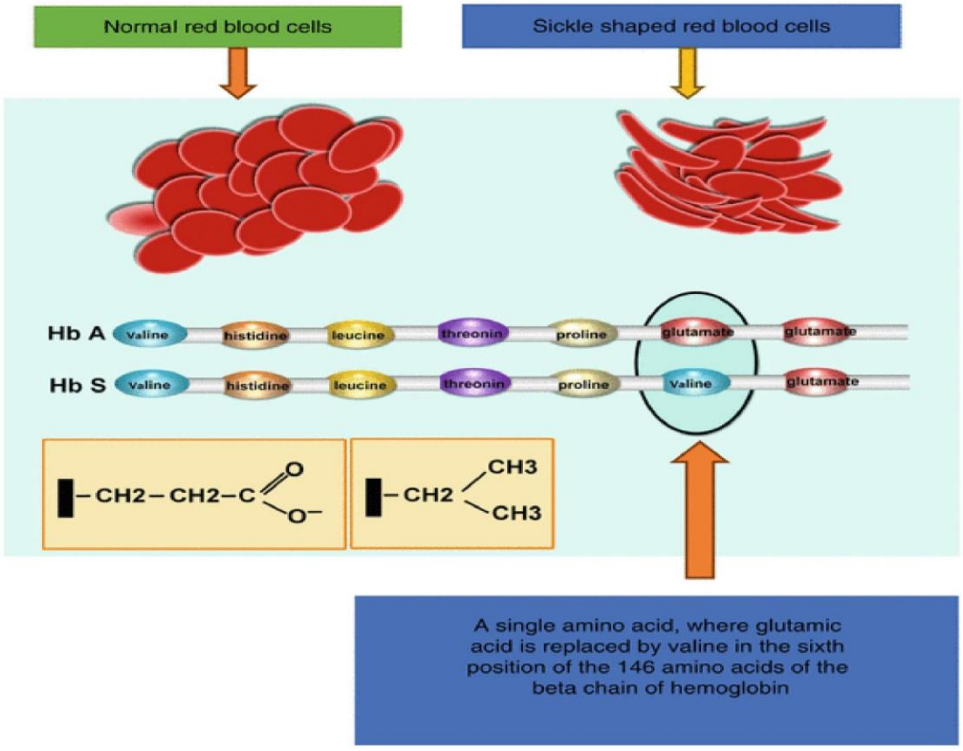
Proteins

Introduction to Protein

- Protein is the three dimensional arrangement of atoms in an amino acid chain molecule.
- Proteins are polymers- specifically polypeptides formed from the sequences of amino acid.
- Proteins are structurally chains of amino acids where the subunits link mutually by covalent bonds which is called peptides.



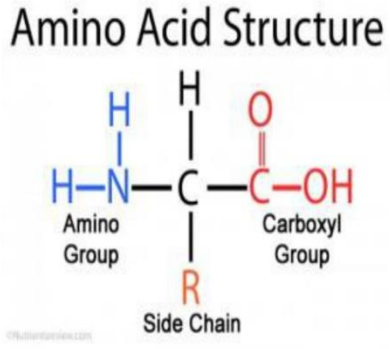
variation of amino acid sequence in normal and sickle cell hemoglobin

Role of Protein

- Building Tissues and Muscles
- Hormone production:- Protein hormones bind to receptors on the cell membrane instead of entering directly.
- Enzymes:-are proteins that binds to molecules to speed up chemical reactions.
- Immune Function:-Antibodies are protein configurations that provide a specific immune defense.
- Energy:- protein are broken during digestion and provide calories.

Amino Acids:- Basic unit of Proteins

- Organic compound that contain amino(-NH_2) and carboxyl(-COOH)functional group, along with side chain(R chain).
- It gets ionized in aqueous solution and behave either as acids or bases.



Types of Amino Acids

- Classified into following classes:

  1) Amino acids with R group

  2) Amino acids with OH hydroxyl group in the side chain

  3) Amino acids with sulphur containing side chain

  4) Amino acids with acidic side chain

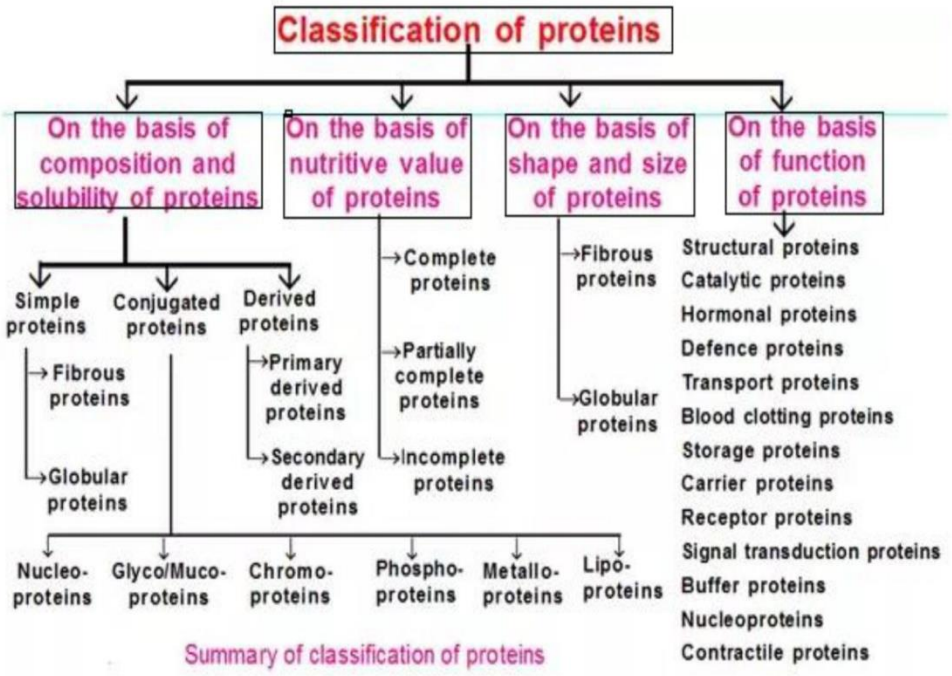
  5) Amino acids with basic side chain

  6) Amino acids with aromatic side chain

  7) Amino acid with imino group

Types of proteins

- On the basis of their functions
- On the basis of their composition
- Derived proteins



Summary of classification of proteins

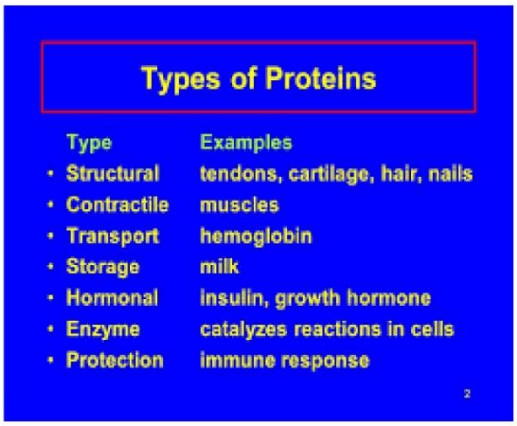
Basis of their Function

- It is of two type

a) Structural protein: Basic component of various structure

b) Functional protein: participates in numerous important functions in the body. It is further divided as:

1) Storage
2) Transport
3) Defense
4) Enzymes
5) Regular
6)Genetic



Basis of their Composition

- Simple proteins:- Composed of amino acid
  - a) Globular Proteins
  - b) Fibrous proteins
- Conjugated proteins:- possess at least one non protein moiety in the structure along with proteineous component. It is divided into following types:
  - a) Lipoprotein
  - b) Glycoprotein
  - c) Nucleoprotein

Basis of their Composition

d) Chromporotein

e) Metalloprotein

f) Phosphoprotein

- Derived Protein: Obtained from denaturation or hydrolysis of the primary polypeptides.

  a) Primary

  b) Secondary

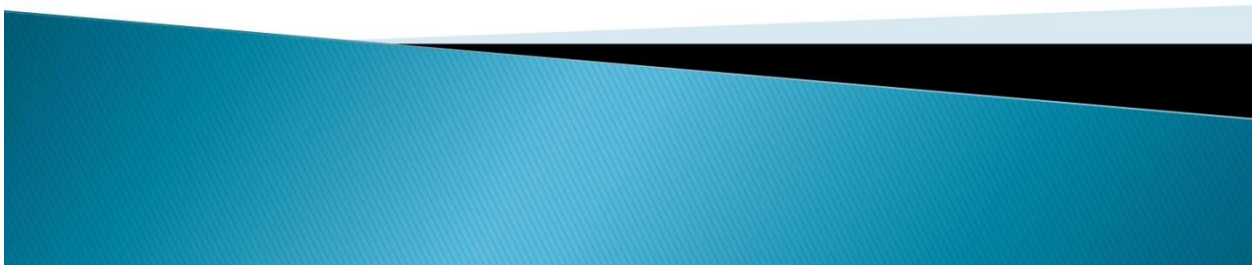
Derived Proteins

- As a result of hydrolysis of the primary polypeptide or protein molecule.
- Divided into two types:

  a) Primary: First product of hydrolysis obtained by denaturation of protein molecule where size remains same.

  b) Secondary: Products obtained by progressive hydrolysis. They are much smaller in size.

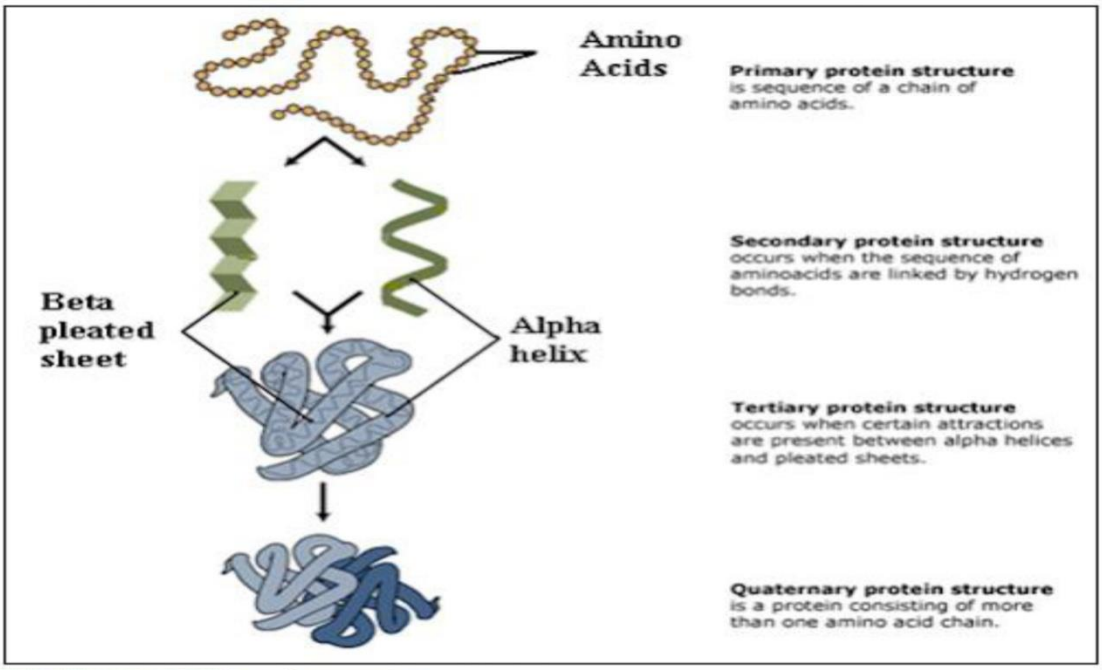
PROTEIN STRUCTURES



Basic Principle of Protein in 3-D Structure

- Every protein molecule has a specific 3-D structure which is determined by Amino acid sequence.
- Structure of protein effects its functioning. Non covalent interactions formed are responsible for maintaining its structure.
- Complex proteins exhibits certain similar structural patterns or confirmations(spatial arrangements of constituents).
- Confirmations which is thermodynamically stable predominate in nature.

Four Levels of Protein Structure



Structure of Protein

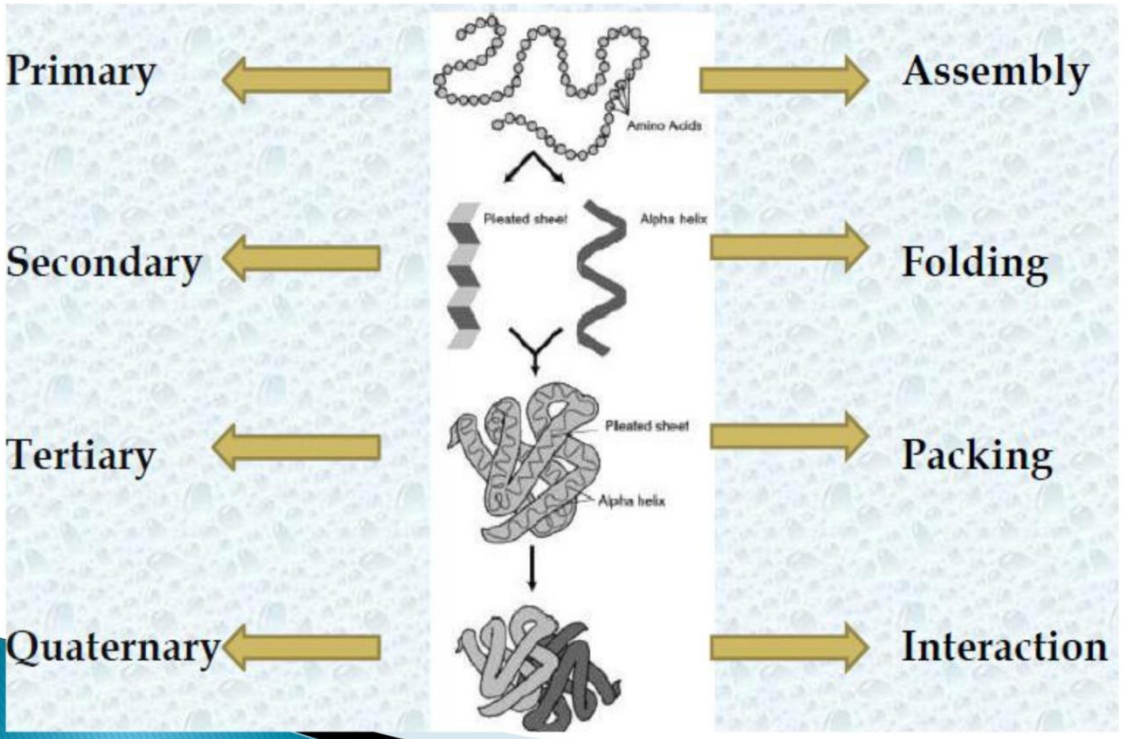
Proteins have different levels of organization

- Primary Structure
- Secondary Structure
- Tertiary Structure
- Quaternary Structure

What Force Determine the Structure?

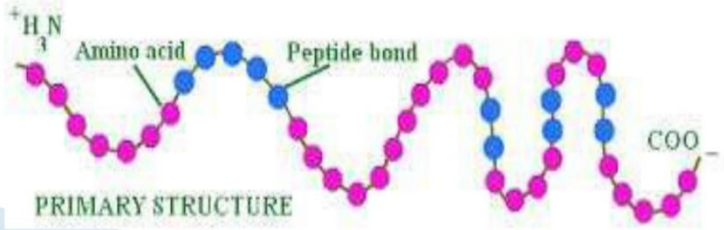
- Primary structure - determined by covalent bonds.
- Secondary, Tertiary, Quaternary structure - determined by weak forces

Protein Structure



Primary Structure

- The primary structure of protein refers to the sequence of amino acids present in the polypeptide chain.
- Amino acids are covalently linked by peptide bonds or covalent bonds.
- Each component amino acid in a polypeptide is called a "residue" or "moiety".
- By convention the primary structure of protein starts from the amino terminal (N) end and ends in the carboxyl terminal (C) end.



Secondary Structure

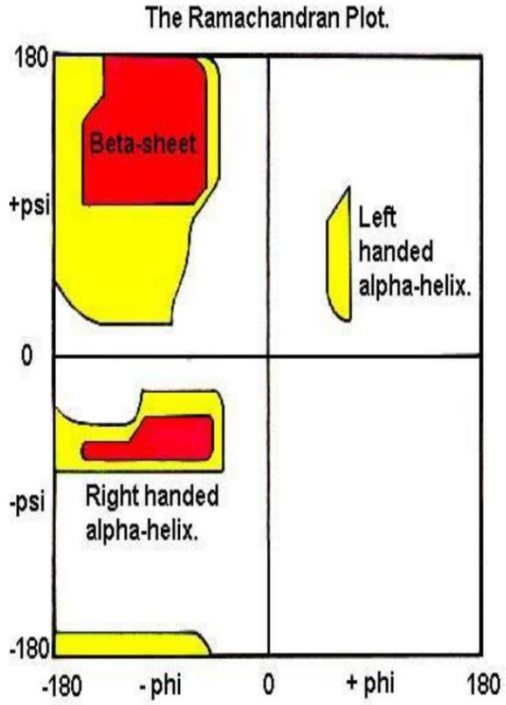
- It is a local, regularly occurring structure in proteins and is mainly formed through hydrogen bonds between backbone atoms.
- Folding of pattern is governed and predominated by numerous weak chemical interaction which stabilize the structure.

Ramachandran plot

- Structures obey two basic concepts which provides better stability. They are:

a) Hydrophobic residue are buried in the interior of protein molecule away from water.

b) Number of hydrogen bonds must be maximized.



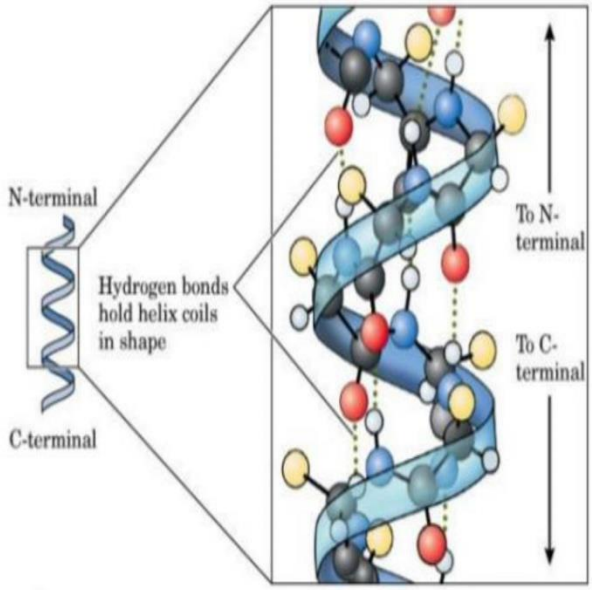
Types of Secondary Structures

- Ordered : Two types
  a) α Helix
  b) β strand/ sheets/ pleated
- Random or Disordered: Which has random coil structure. It is of two Type
  a) β turn /bends (Reverse Turn)
  b) Super
    1) Super helix
    2) Triple helix

α Helix

Protein backbone is arranged in spiral like structure having following features:

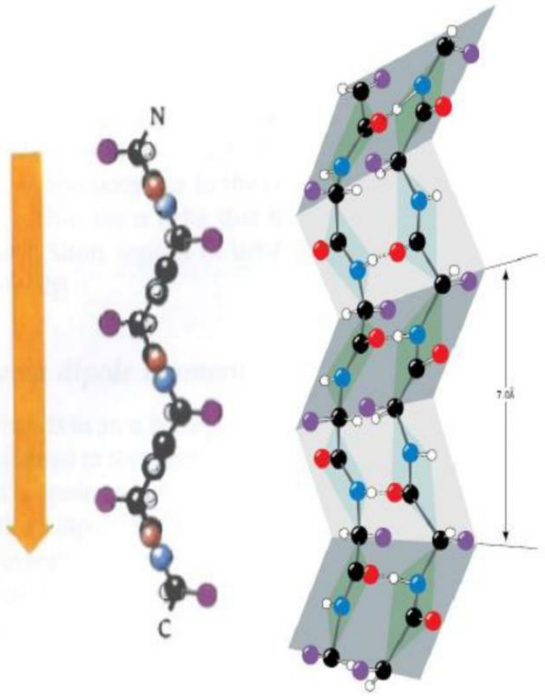
- Backbone is twisted into right handed helix.
- All peptide bonds excepts first and last participate in hydrogen bond formation.
- Right handed α helix is more stable than the left handed one.



β strand

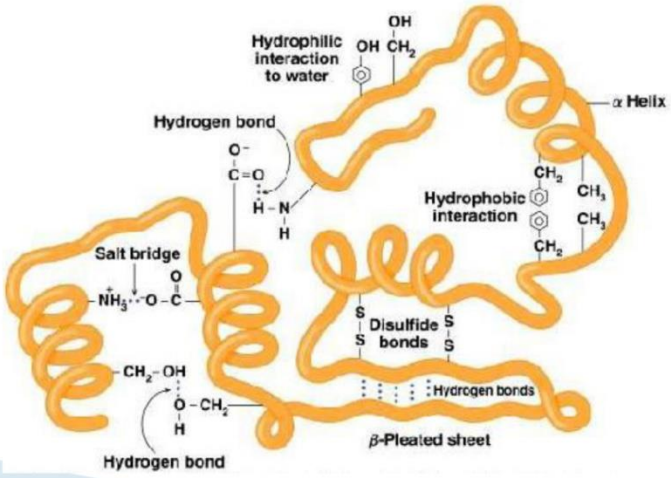
β structure has following features:

- Polypeptide chains arrange in side by side forming a sheet.
- Number of chains included vary from 2 to 5.



Tertiary Structure

- The tertiary structure defines the specific overall 3-D shape of the protein.
- Tertiary structure is based on various types of interactions between the side-chains of the peptide chain



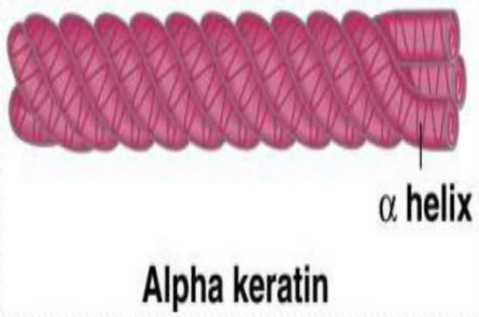
Types of Tertiary Structure

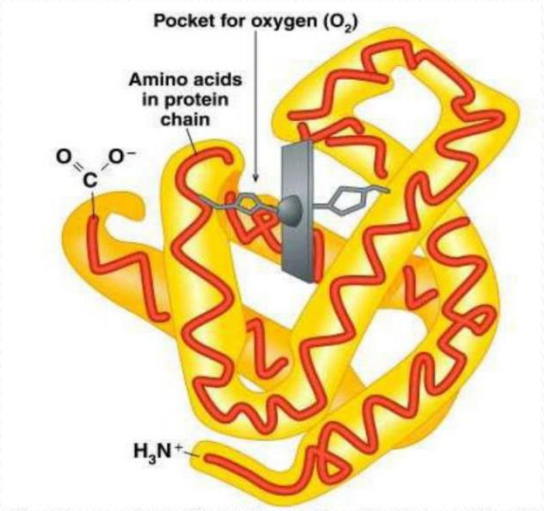
It is of two types:

- Fibrous Protein: Fibrous proteins consist of long fibers and are mainly structural proteins. It have elongated structure due to coiling of more than one helix along their longitudinal axis.

- Globular Protein: Compact round spherical protein in which chain occupy the centre and amino acid lie on the surface.

Diagrammatic Representation



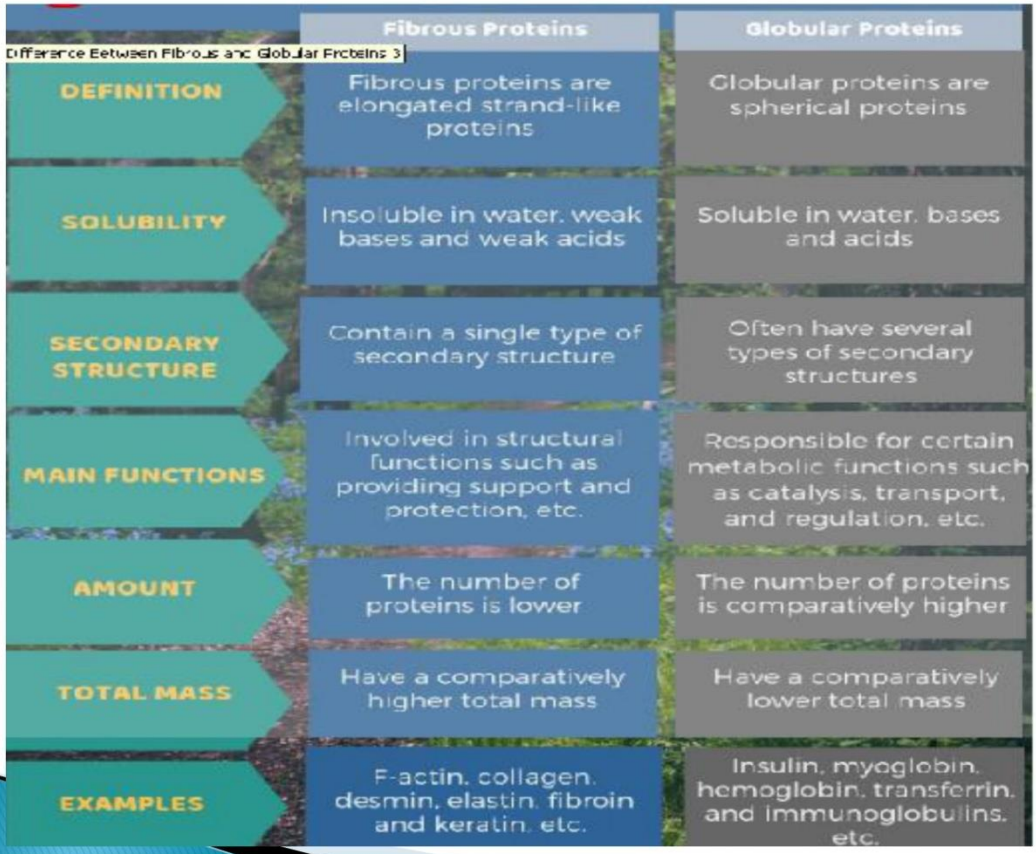


Fibrous Protein

Globular Protein

What are the Similarities Between Fibrous and Globular Proteins?

- Fibrous and globular proteins are types of proteins composed of amino acids.
- Both serve as structural proteins as well as functional proteins.
- Also, both have primary and secondary structures.
- Furthermore, they are essential molecules for the growth and development of living organisms.


Difference Between Fibrous and Globular Proteins 3
Fibrous Proteins
Globular Proteins
DEFINITION
Fibrous proteins are elongated strand-like proteins
Globular proteins are spherical proteins
SOLUBILITY
Insoluble in water, weak bases and weak acids
Soluble in water, bases and acids
SECONDARY STRUCTURE
Contain a single type of secondary structure
Often have several types of secondary structures
MAIN FUNCTIONS
Involved in structural functions such as providing support and protection, etc.
Responsible for certain metabolic functions such as catalysis, transport, and regulation, etc.
AMOUNT
The number of proteins is lower
The number of proteins is comparatively higher
TOTAL MASS
Have a comparatively higher total mass
Have a comparatively lower total mass
EXAMPLES
F-actin, collagen, desmin, elastin, fibroin and keratin, etc.
Insulin, myoglobin, hemoglobin, transferrin, and immunoglobulins, etc.

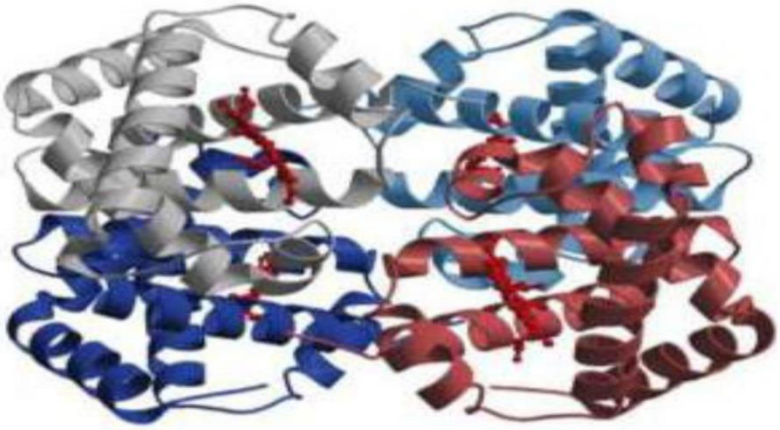
Quaternary Structure

- The quaternary protein structure involves the clustering of several individual peptide or protein chains into a final specific shape.
- A variety of bonding interactions including hydrogen bonding, salt bridges, and disulfide bonds hold the various chains into a par
- Two kinds of quaternary structures: both are multi subunit proteins.

  a) Homodimer : association between identical polypeptide chains.

  b) Heterodimer : interactions between subunits of very different structures.

Quaternary Structure



HIERARCHY IN PROTEIN STRUCTURE

TWO CLASSES OF PROTEIN

- **Class I:-** Folded by hierarchal mechanism. It is found on the cell surface of all nucleated cells in the bodies of vertebrates.
- Their function is to display peptide fragments of proteins from within the cell to cytotoxic T cells(that kills cancer cells).
- This will trigger an immediate response from the immune system against a particular non-self antigen displayed with the help of class I protein.

TWO CLASSES OF PROTEIN

- **CLASS II:-** Folds rapidly and do not form any intermediate. This kind of folding involves change of polypeptide chain into compact stable state by hydrophobic (the fear of water) interaction.
- To present processed antigens, which are derived primarily from exogenous (growing or originating from outside an organism) sources, to CD4(+) T-lymphocytes(help coordinate the immune response by stimulating other immune **cells**).
- **Class II** molecules are critical for the initiation of the antigen-specific immune response.

STEPS IN HIERARCHAL ARCHITECTURE

- Formation of polypeptide chain
- Formation of secondary structure
- Local secondary structure formed undergoes long range interaction.
- Formation of Tertiary structure.
- Formation of Quaternary Structure

BOND STABILIZING

- Hydrogen Bond:- Weak ionic interaction between positively charged H atom and negatively charged atom like oxygen.
- Hydrophobic Interaction:- between non polar side chain of neutral amino acid.
- Electrostatic Bond:- between positively charged atom and negatively charged atom like oxygen.
- Vander Waals Force:- non covalent associations between electrically neutral group formed due to dipoles.

TYPES OF BONDS