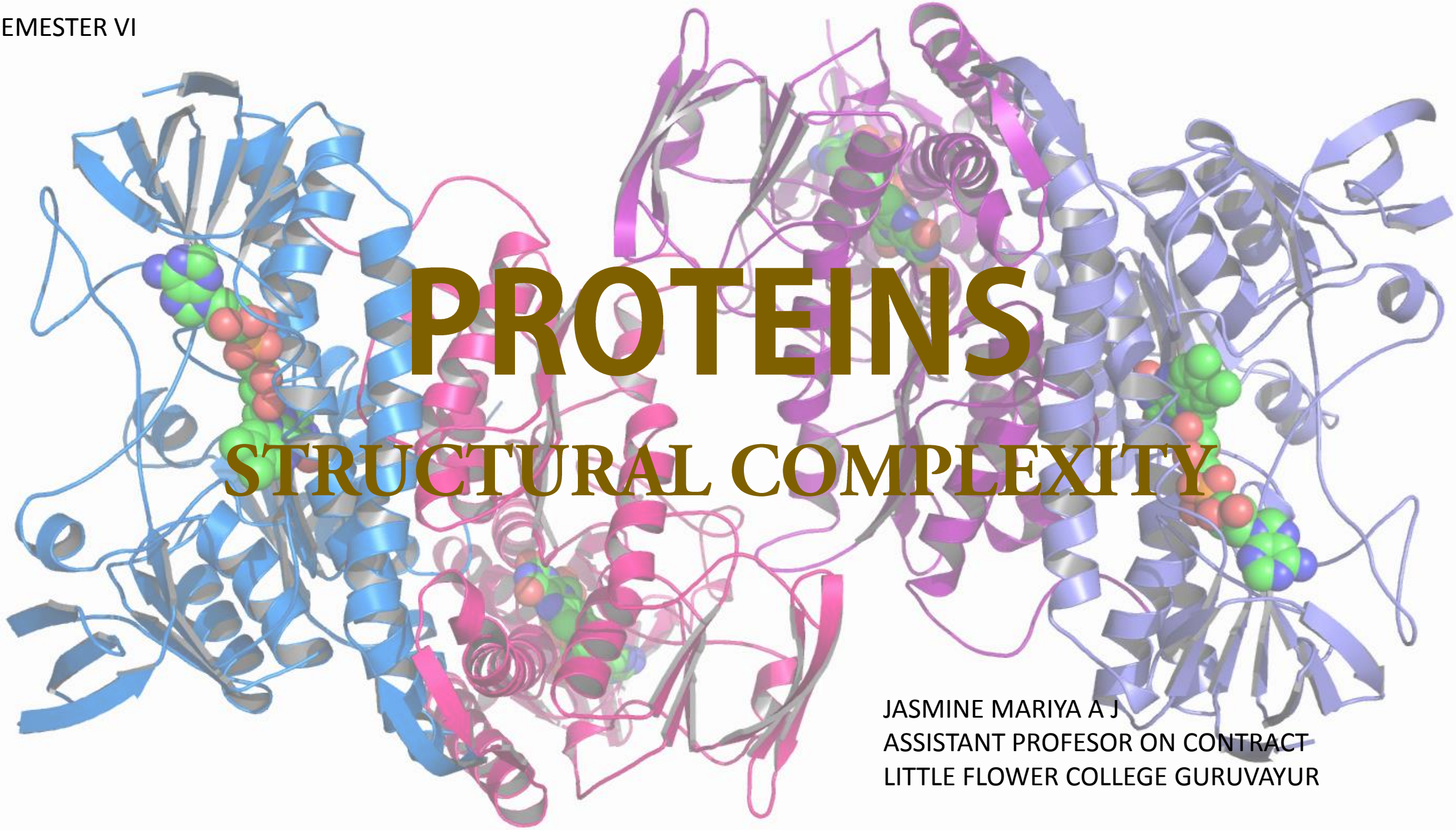
SEMESTER VI



PROTEINS

STRUCTURAL COMPLEXITY

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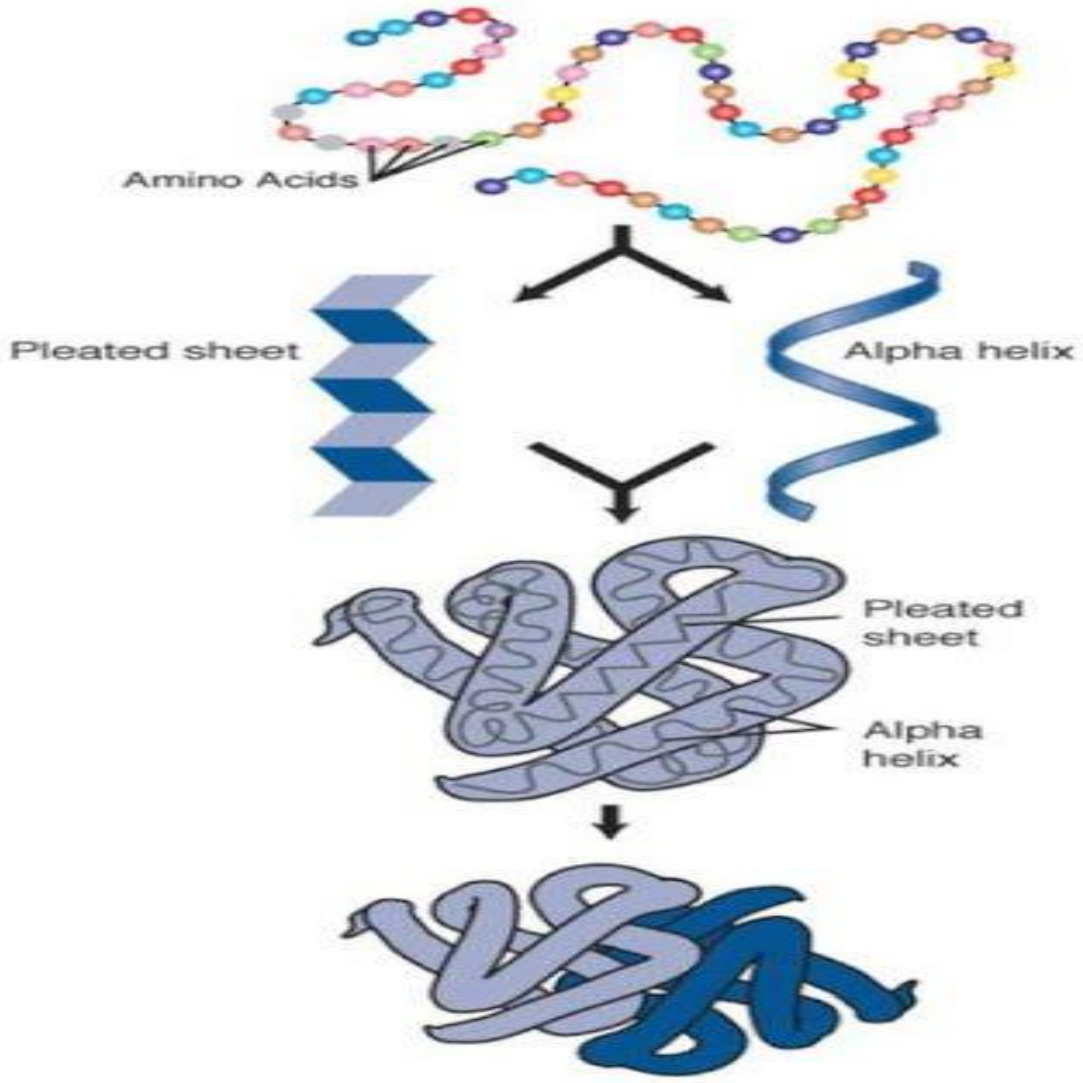
Proteins

- A protein is a naturally occurring, extremely complex substance that consists of amino acid residues joined by peptide bonds.
- Proteins are present in all living organisms and include many essential biological compounds such as enzymes, hormones, and antibodies.
- Process of synthesis of protein is called translation, it occurs in the cytoplasm in ribosomes
- We get proteins through the diet called, dietary proteins which is utilized for the energy purpose ,building of muscles and bones.
- Cellular proteins made by the cells through translations control all biological activities like signalling, catalysis etc.

Levels of structural organization in proteins



Levels of protein organization

Primary protein structure
is sequence of a chain of amino acids

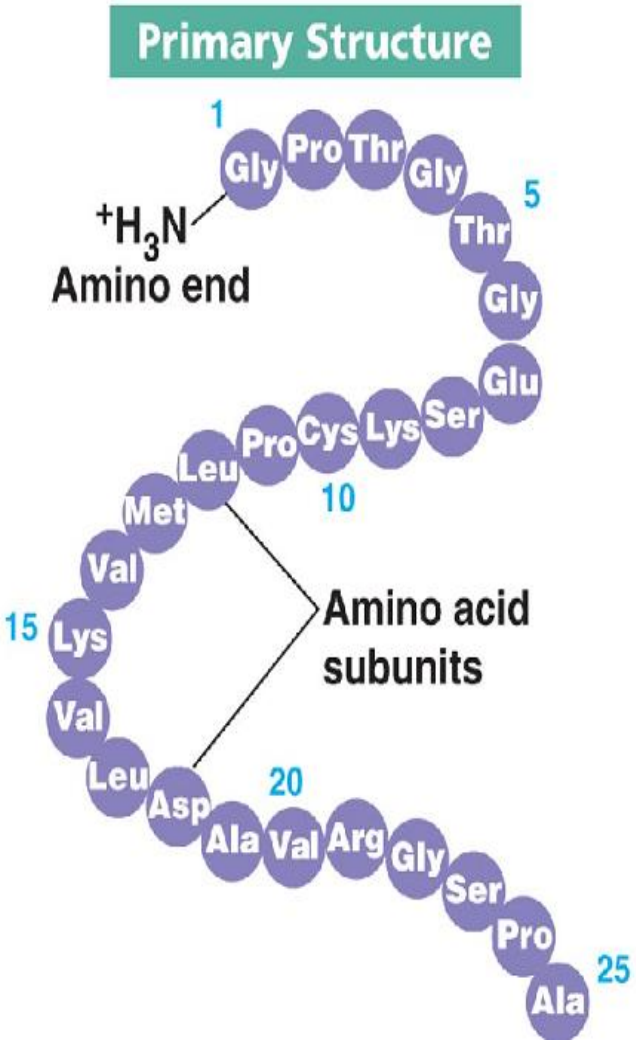
Secondary protein structure
occurs when the sequence of amino acids are linked by hydrogen bonds

Tertiary protein structure
occurs when certain attractions are present between alpha helices and pleated sheets.

Quaternary protein structure
is a protein consisting of more than one amino acid chain.

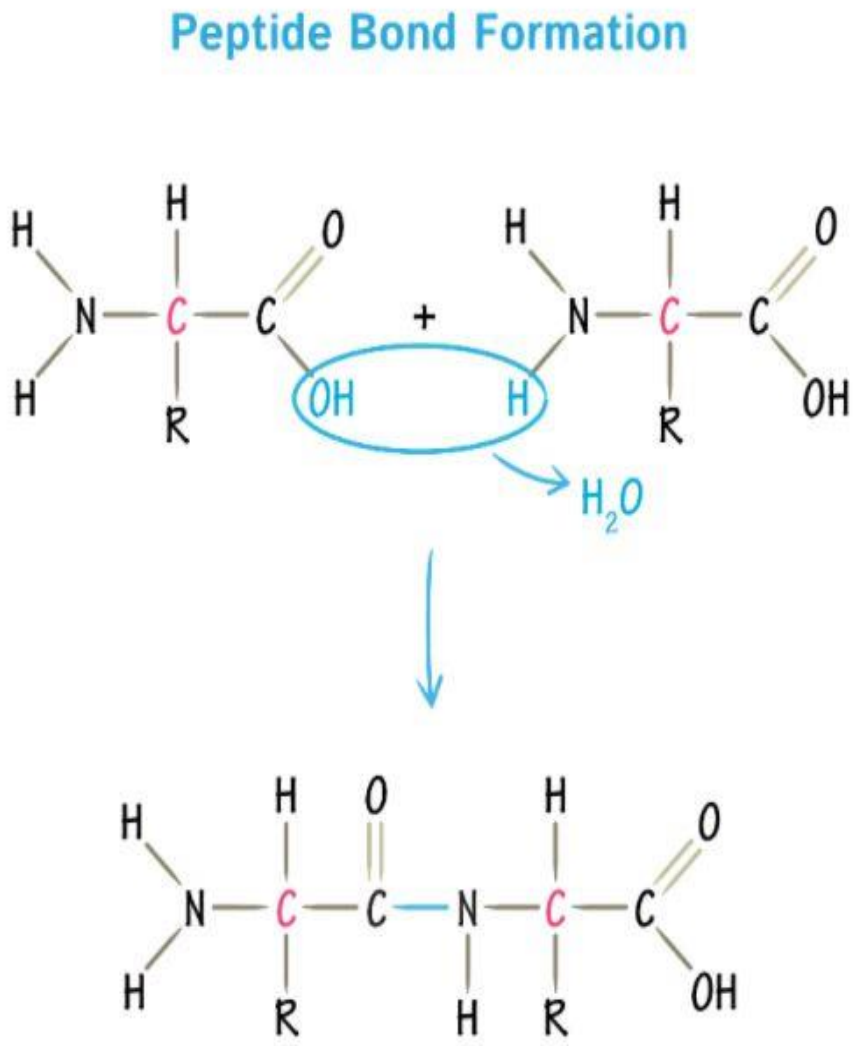
Primary structure of proteins

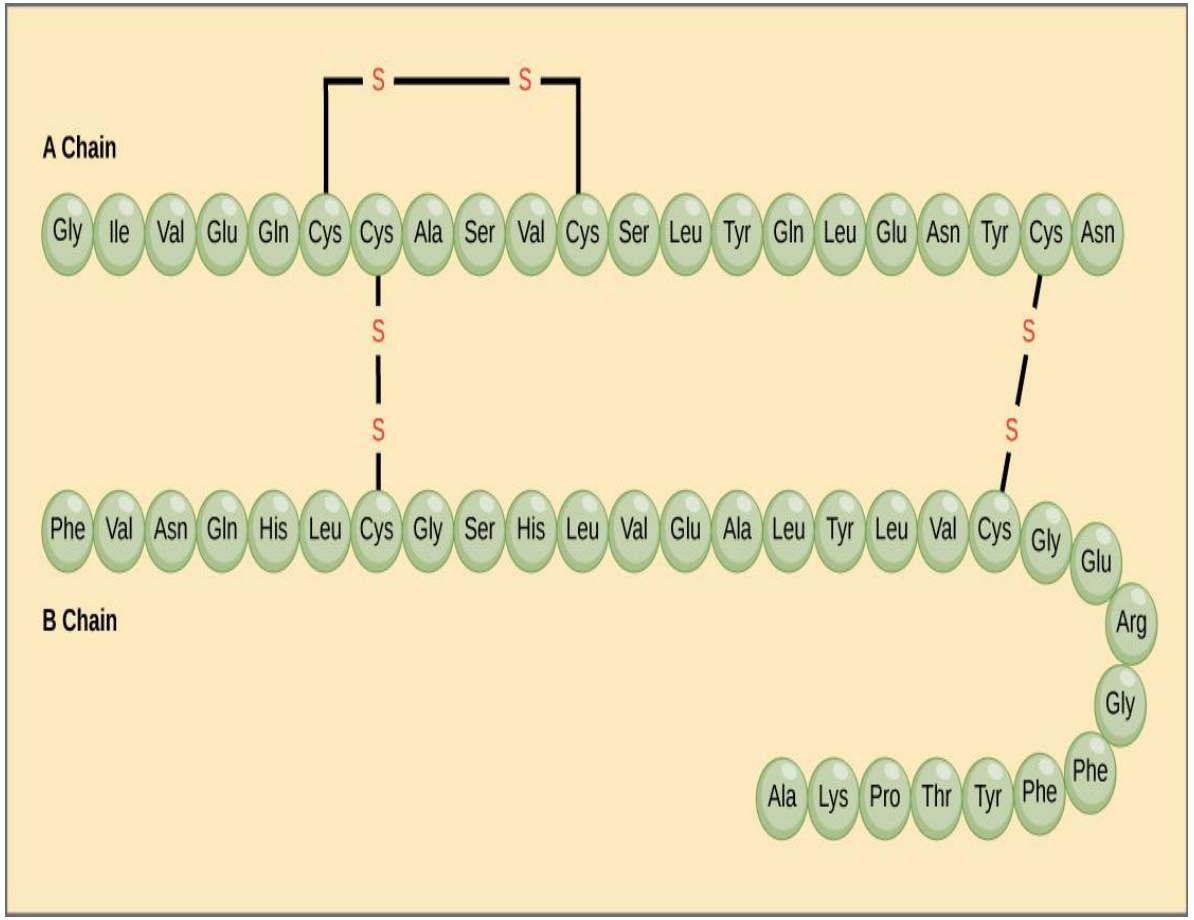
- It is the sequential covalent linkage(Peptide bond) of amino acids to form a polypeptide chain
- It is the simplest level of protein structure
- Primary protein structure is specified by the genetic code
- It is an unbranched linear chain structure



Amino Acid	Abbreviations
Alanine	Ala; A
Arginine	Arg; R
Asparagine	Asn; N
Aspartic acid	Asp; D
Cysteine	Cys; C
Glutamic acid	Glu; E
Glutamine	Gln; Q
Glycine	Gly; G
Histidine	His; H
Isoleucine	Ile; I
Leucine	Leu; L
Lysine	Lys; K
Methionine	Met; M
Phenylalanine	Phe; F
Proline	Pro; P
Serine	Ser; S
Threonine	Thr; T
Tyrosine	Tyr; Y
Tryptophan	Trp; W
Valine	Val; V

- Peptide bonding is an endergonic process
- this bond formation reaction is catalysed by the enzyme peptidyl transferase which is present in the ribosomes
- The protein have two ends ,one amino terminal end called N terminal and one carboxy terminal end called C terminal

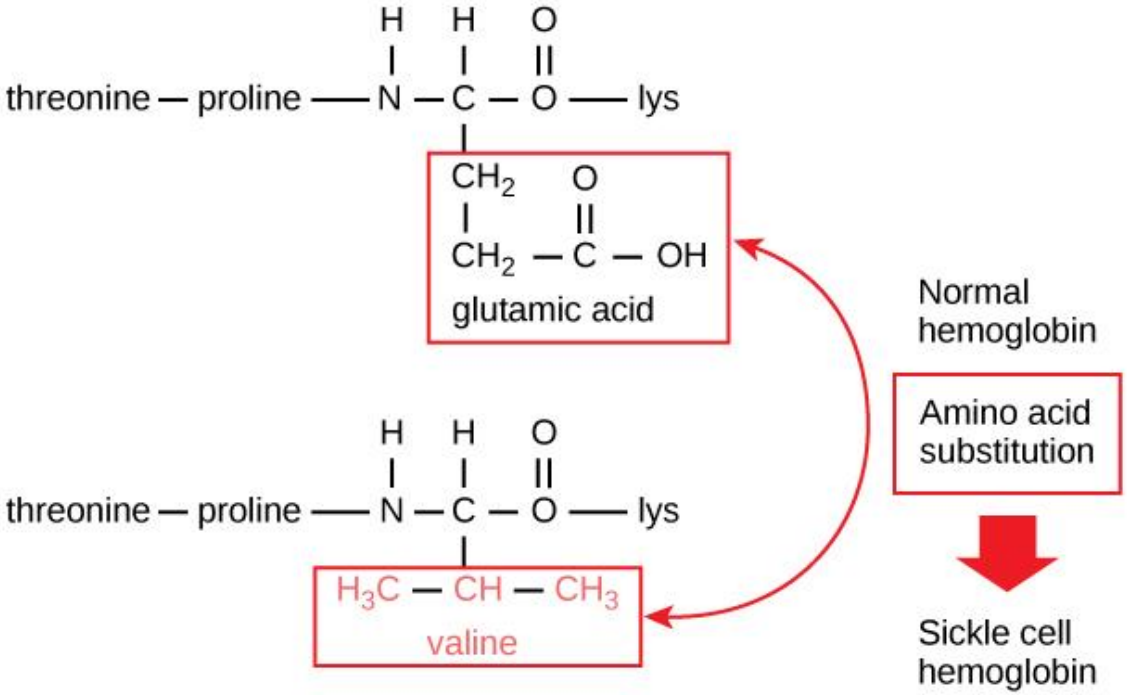




Insulin – example for primary structure

- The hormone insulin has two polypeptide chains, A and B.
- Each chain has its own set of amino acids, assembled in a particular order.
- The sequence of the A chain starts with glycine at the N-terminus and ends with asparagine at the C-terminus, and is different from the sequence of the B chain.

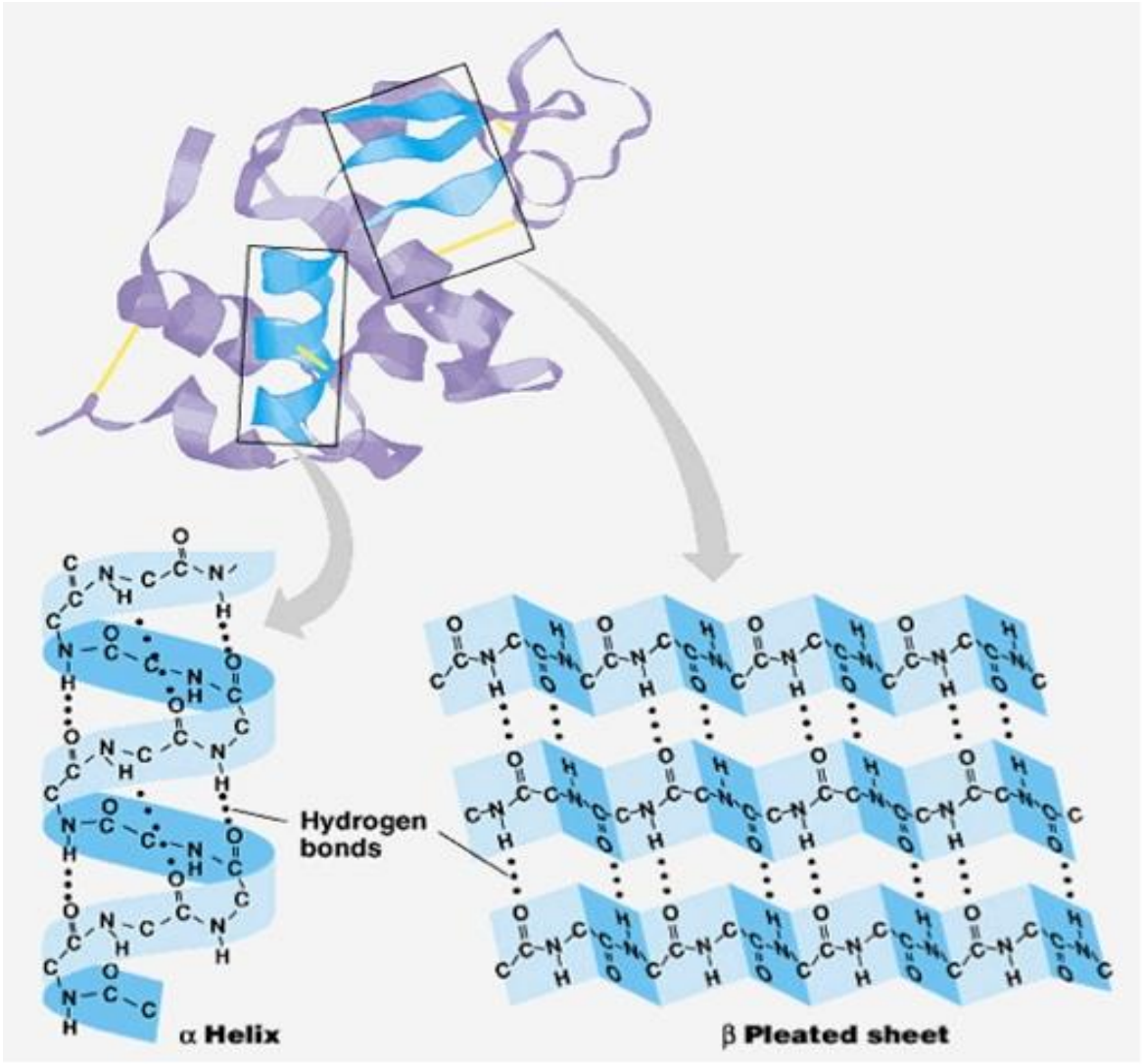
- A change in the gene's DNA sequence may lead to a change in the amino acid sequence of the protein.
- Even changing just one amino acid in a protein’s sequence can affect the protein’s overall structure and function.
- Eg: sickle cell anemia



- The glutamic acid that is normally the sixth amino acid of the haemoglobin β chain (one of two types of protein chains that make up haemoglobin) is replaced by a valine.

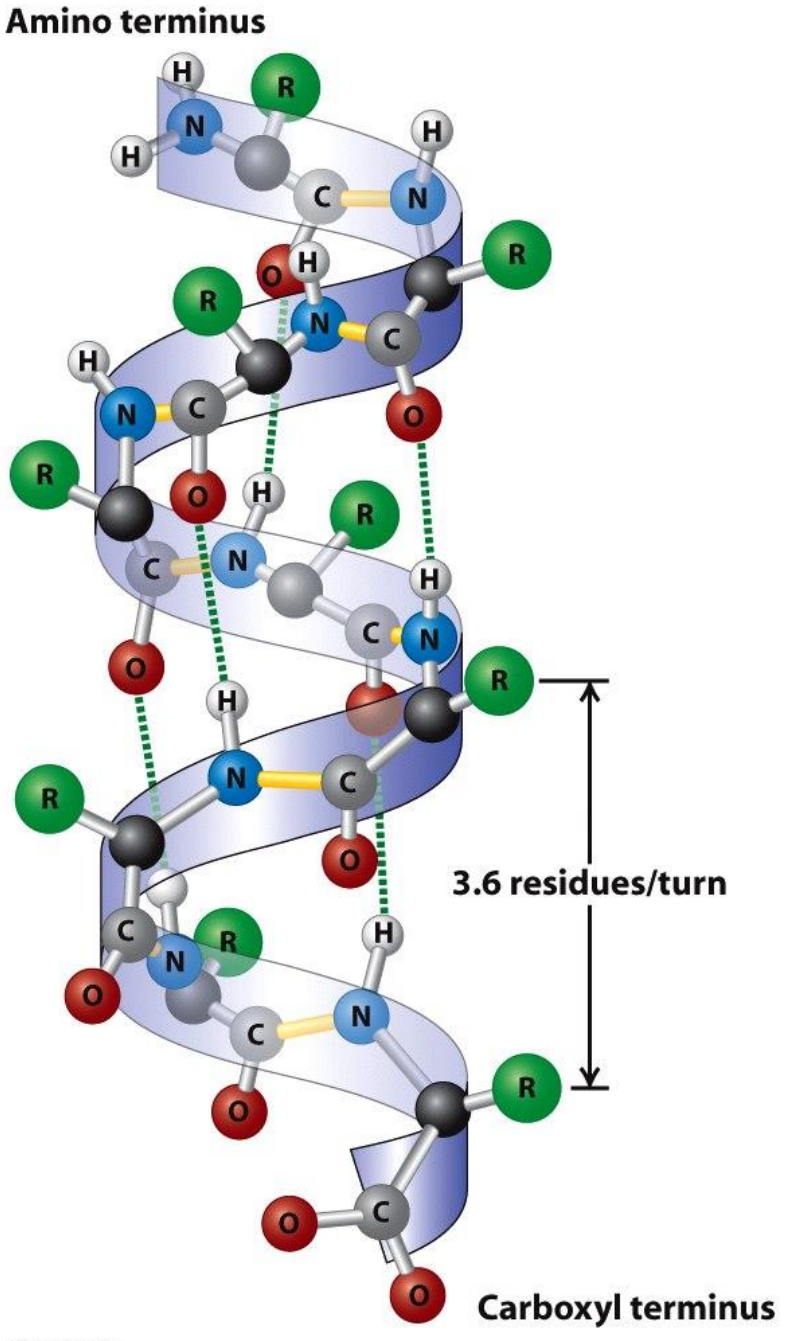
Secondary structure of proteins

- Refers to local folded structures that form within a polypeptide due to interactions between atoms of the backbone.
- This structural organisation make the protein molecule short, rigid and compact
- During the formation of a peptide bond the carboxyl O will get partial negative charge and amino H will get a partial positive charge .They will undergo Hydrogen bonding to form the secondary structure
- This is found in fibrous proteins, such as keratin in hair, collagen and elastin of connective tissue ,myosin of muscles fibrin of blood clot ,fibroin of silk etc.
- There are mainly two types of secondary structures namely alpha helix and beta pleats



i) Alpha helix

- In an **α helix**, the carbonyl (C=O) of one amino acid(n th) is hydrogen bonded to the amino H (N-H) of an amino acid that is four down the chain(n+4 th). (E.g., the carbonyl of amino acid 1 would form a hydrogen bond to the N-H of amino acid 5.)
- One complete turn of alpha helix would have 3.6 amino acids
- It can be right handed as well as left handed
- All naturally occurring alpha helices are right handed (because all naturally occurring amino acids are left handed)



- The R groups of the amino acids stick outward from the α helix
- Amphipathic alpha helices will have non polar hydrophobic residues on one surface and polar hydrophilic residues on the other side

ii)Beta pleats

- This structure occurs when two (or more, e.g. ψ-loop) segments of a polypeptide chain overlap one another and form a row of hydrogen bonds with each other.
- This can happen in a parallel arrangement as well as in anti parallel arrangement
- They are usually twisted in a right handed direction
- Beta sheet is characteristic of proteins which makes up silk fibres.
- The sheen of silk is due to the reflective property of the beta sheets

Tertiary structure of proteins

- Extensive helical twisting and irregular folding ,bending, looping of the polypeptide chain.
- It makes protein molecule almost spherical
- Tertiary structures are stabilised by disulphide bonds,hydrogen bonds,hydrophobic bonds and vanderwalls interactions

- It is the most stable structural form
- Important biological properties such as enzyme activity and antigenicity etc, are related to it.

Quaternary structure of proteins

- 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**.
- A multi stranded protein with different kinds of subunits are called multimer, and one with atleast two identical subunits are called oligomer
- The identical subunits of an oligomer is called protomer
- Quaternary structures are stabilised by non covalent interactions such as electrostatic and hydrophobic interactions

Examples of quaternary structure of proteins