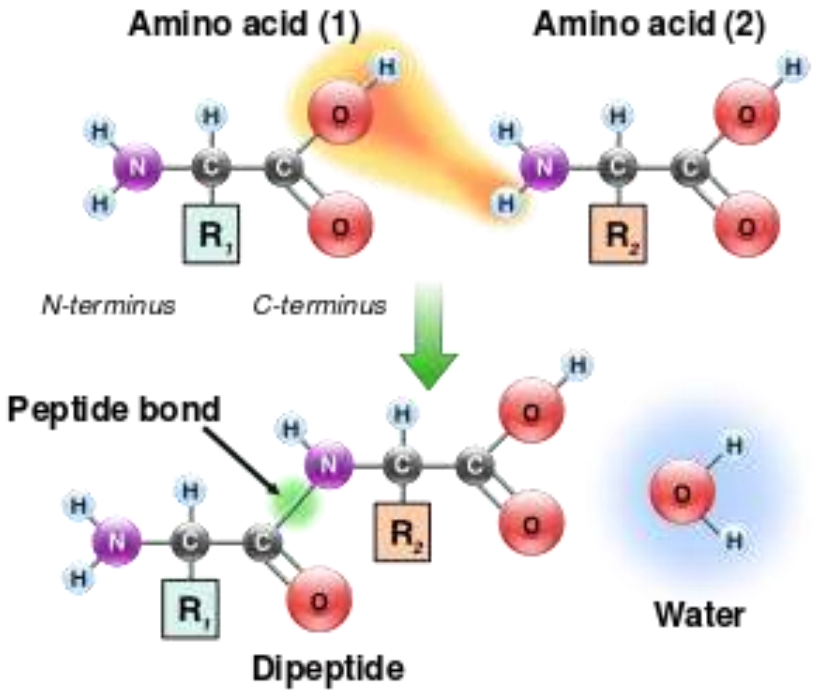
Proteins

Proteins

- most abundant intracellular macromolecule.
- central position in architecture and functioning of living matter.
- important stuructal elements, functional like hormone, enzymes.
- determines the phenotype of a cell.
- where to go, what to do, when and how to perform

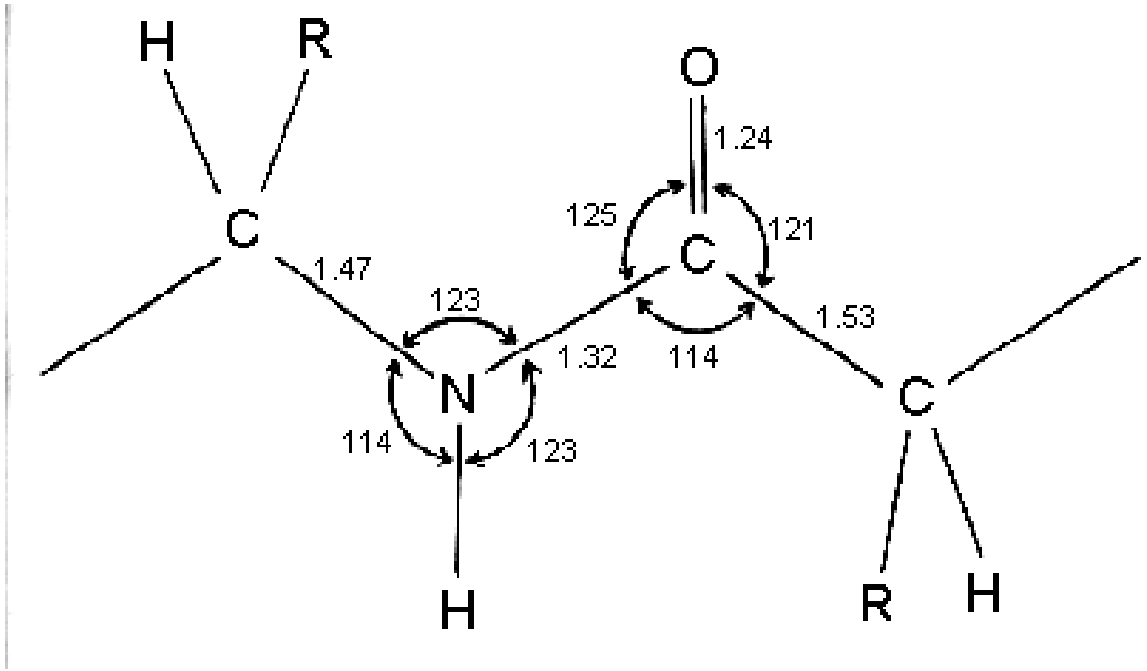
Peptides

- amino acids linked together by carboxyl and amino group
- special amide bond called peptide bond.



N Terminal amino acid and
C Terminal amino acid

Peptide chain dimension



Classification of proteins

- Based on shape globular and fibrous
- Globular proteins are spherical or oviid shape
- Usually soluble in water
- Almost all enzymes, peptide hormones, blood
- Proteins ,antibodies and storage proteins are globular
- Fibrous proteins are long ribbon shape

- Insoluble in all common solvents
- Extremely strong can stretcha and recoil to original structure
- Includes proteins in connective tissue, bones, blood vessels, skin, hair nails wool and silk
- Collagens, elastins ketatins and fibroin are eg for fibrous proteins

Classification based on composition

- Simple conjugated and derived proteins
- Simple proteins contains only amino acids as structural components
- On decomposition it liberates amino acids
- Histones, albumins, globulins glutelins prolamines, Scleroproteins are simple proteins
- Conjugated proteins linked with non proteins portion called prosthetic group

- May be a metal or any compound
- Metalloproteins, chromoproteins, glycoproteins, phosphoproteins, lipoproteins, nucleoproteins are conjugated proteins
- Derived proteins are derivatives of proteins resulting from heat, enzyme or chemical reagents.
- Proteans, coagulated proteins, proteoses, peptones are derived proteins

Properties of proteins

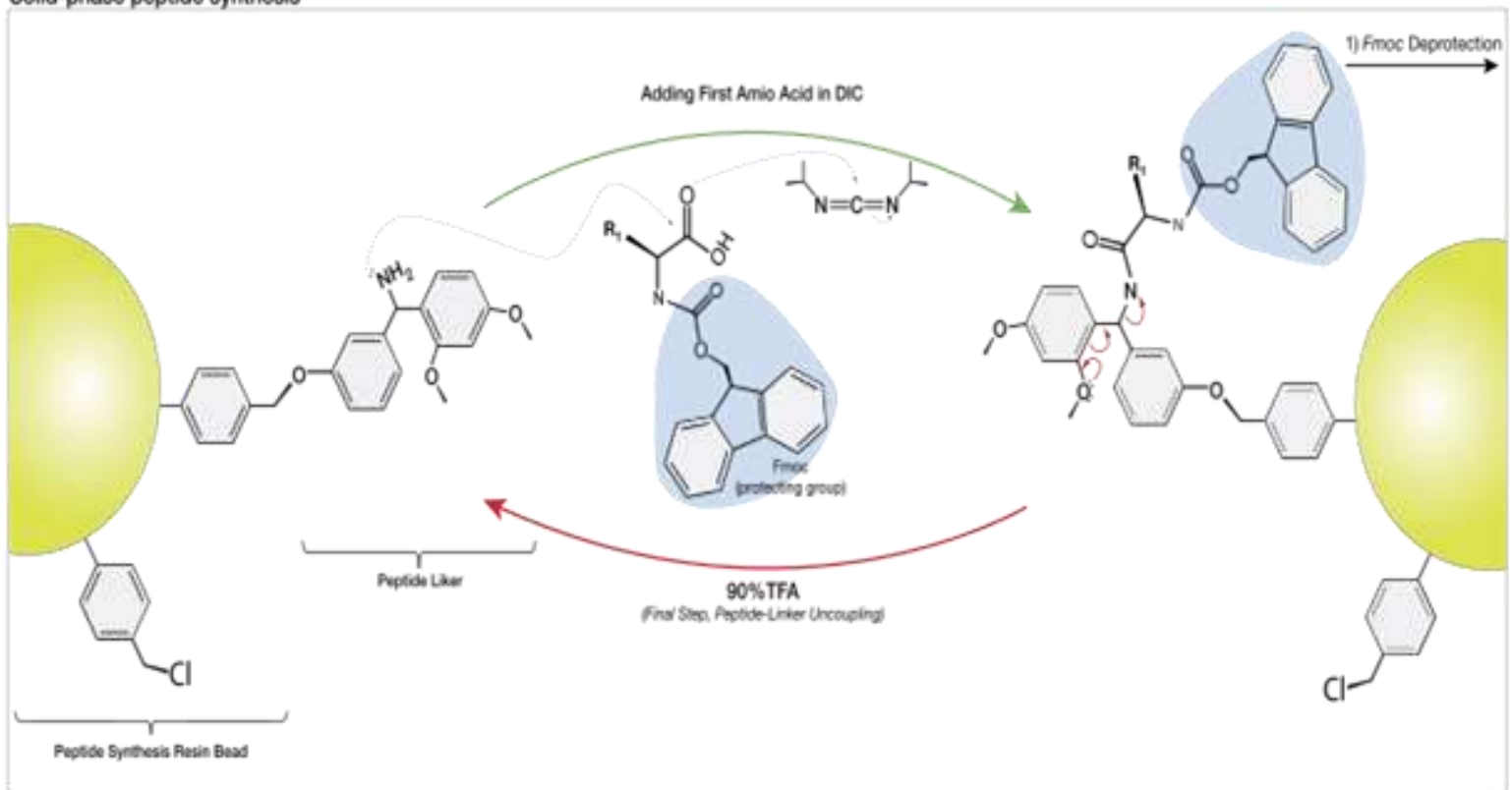
Physical properties

- Colourless and tasteless
- Vary from simple spherical to long fibrillar structures
- Each protein molecule has specific size
- Diffusion rate is very slow due to colloidal nature
- Denaturation by unfolding of peptide chains
- Amphoteric in nature
- Isoelectric point
- Can be hydrolyzed by acids, alkali and preteolytic enzymes

Chemical synthesis of peptides

- Coupling the carboxyl group or C-terminus of one amino acid to the amino group or N-terminus of another.
- Chemical peptide synthesis starts at the C-terminal end but protein biosynthesis, starts at the N-terminal end.
- Two methods liquid phase synthesis and solid phase synthesis
- Liquid phase used for short peptide synthesis now replaced by solid phase synthesis

Solid-phase peptide synthesis

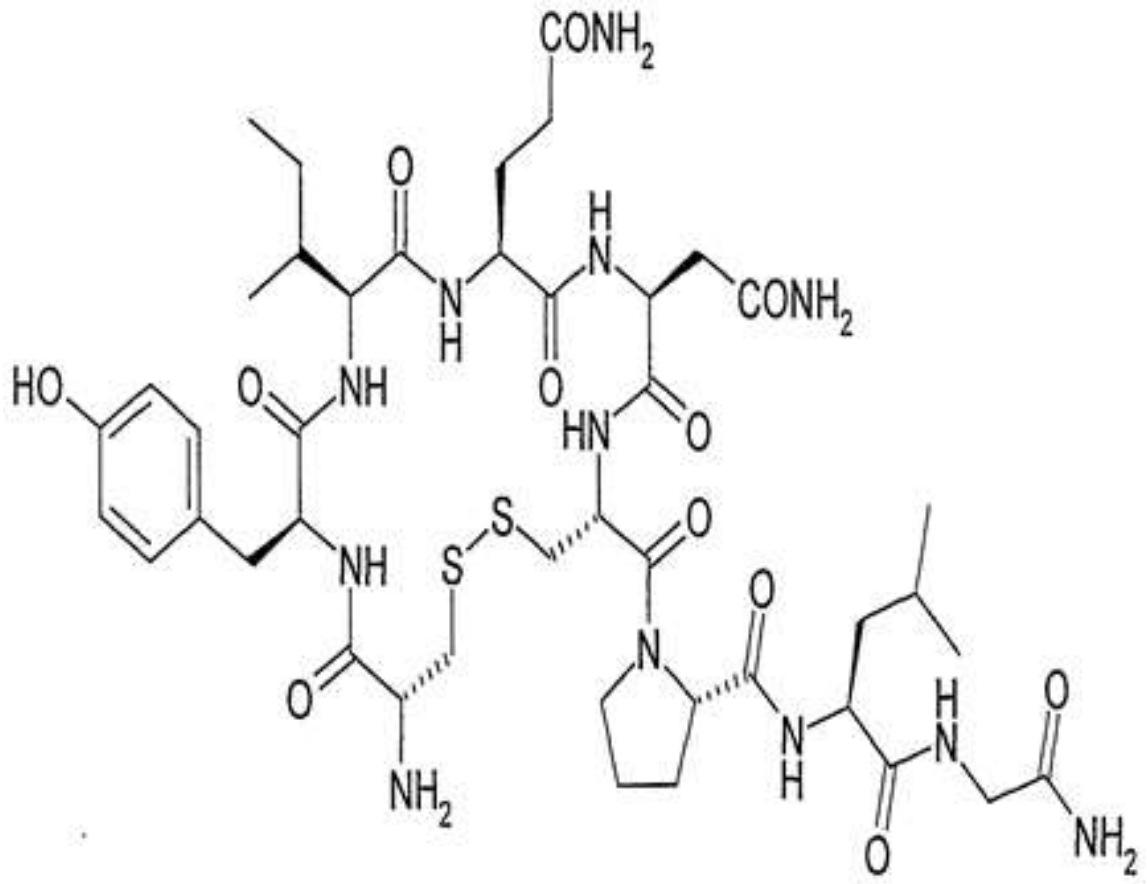


Protein structure

- The net structure attained by linking various amino acids
- Achieved by various chemical bonds
- Categorized as primary and secondary bonds
- Primary bond – peptide bond found in all proteins
- Secondary bond – each protein does not coincide with structure
- Indicates variety of secondary bonds other than primary bond hold the structure

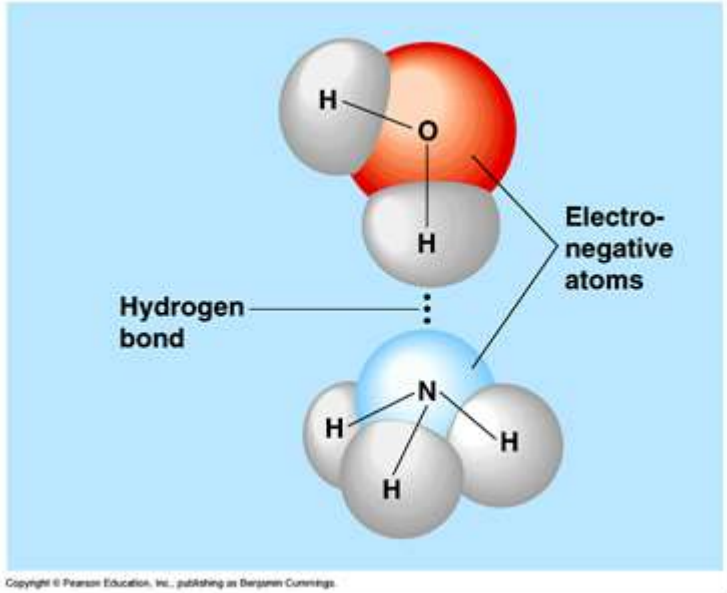
Disulfide bond - -s-s-

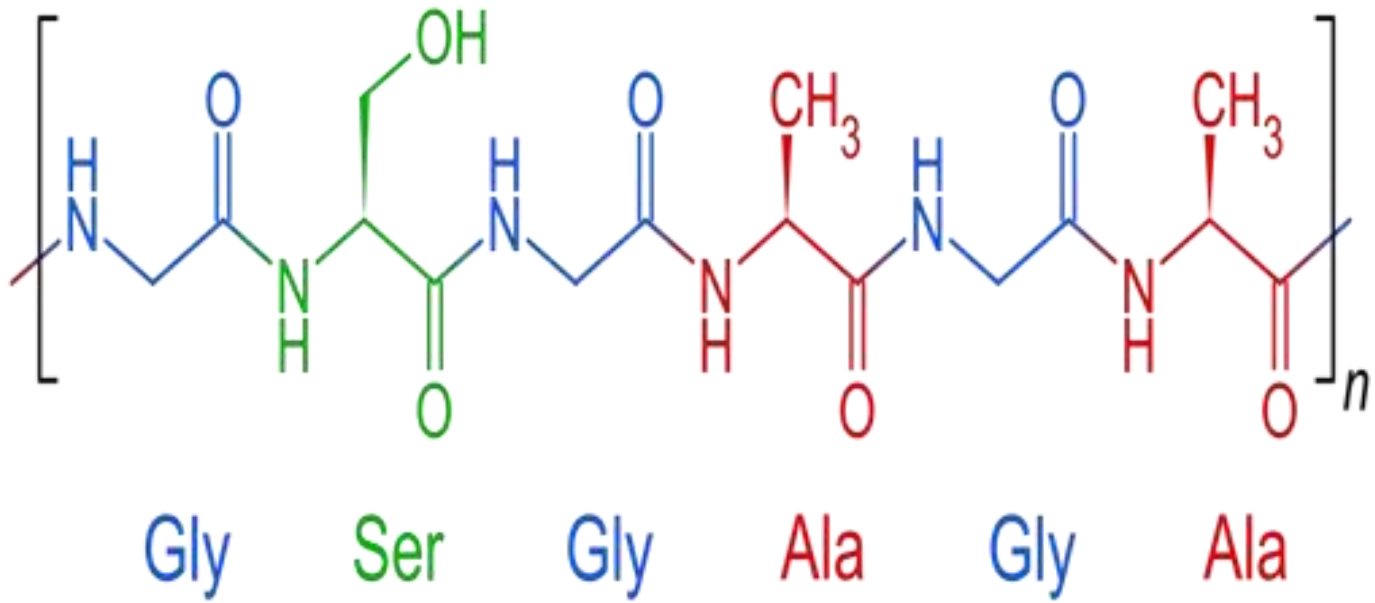
Eg . Oxytocin disulfide bond between two cysteine amino acids



Hydrogen bond – CO---HN

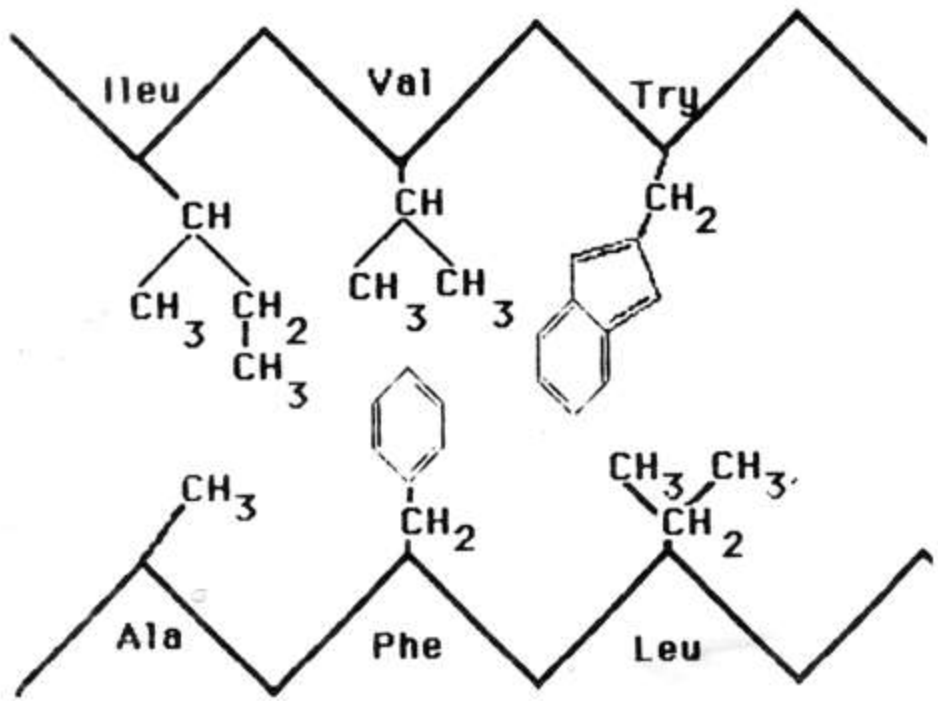
- Hydrogen atom share its electron with its neighboring atoms especially O and N.
- Eg silk fibroin glycine alanine and serine linked by hydrogen bond




OH
O
H
N
O
CH3
O
CH3
H
N
H
N
H
N
N
H
O
O
O
n
Gly
Ser
Gly
Ala
Gly
Ala

Hydrophobic bond

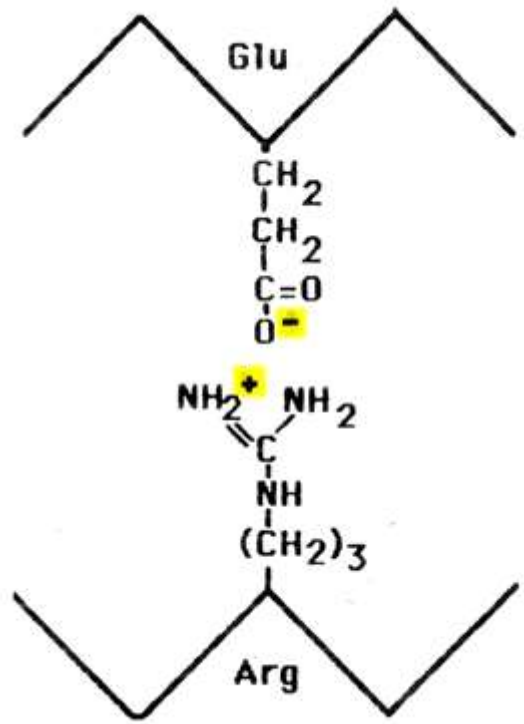
- Amino acids like ala, val, leu, etc., have hydrophobic R group
- Such R groups form hydrophobic bond among themselves by eliminationg water molecule
- Relatively strong bond


Ileu
Val
Try
CH
CH
CH2
CH3
CH2
CH3
CH3
CH3
CH3
CH3
CH2
CH2
Ala
Phe
Leu

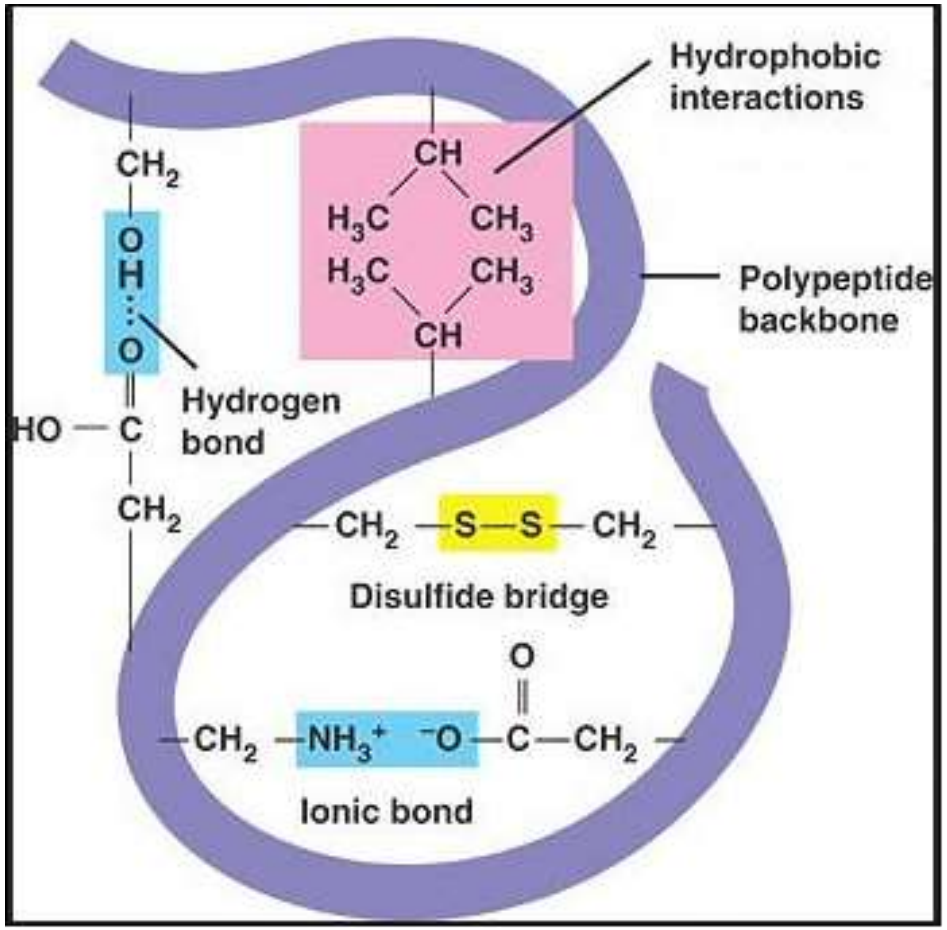
Ionic bond

- Ions possess similar charge repel whereus dissimilar charges attract eachother

- In proteins ionic bonds formed between positive charged amino acids (lys, arg, his) and negatively charged groups (asp acid, glu acid).


Glu
CH2
CH2
C=O
O-
NH2+
NH2
C
NH
(CH2)3
Arg

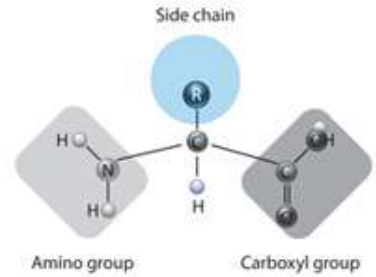
Forces in protein structure

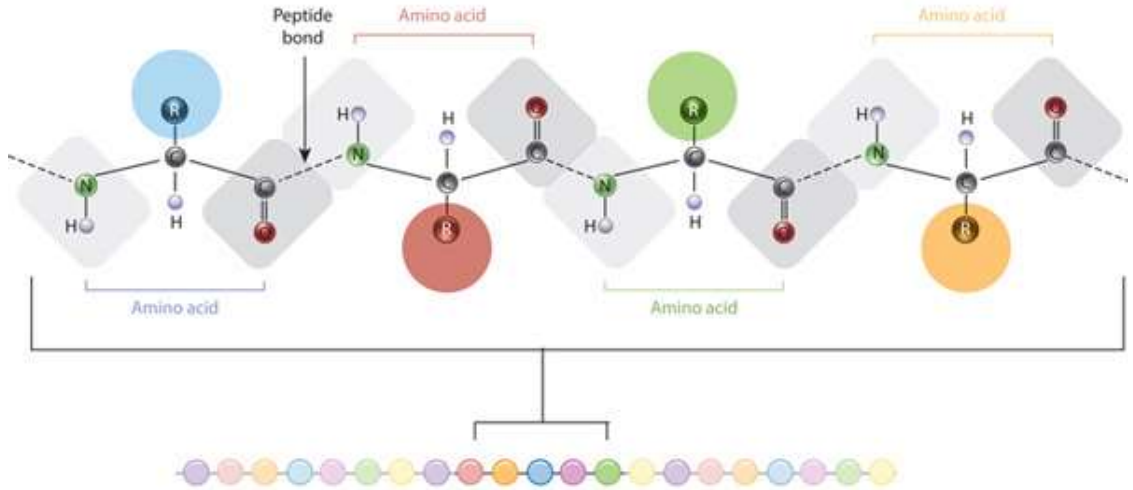


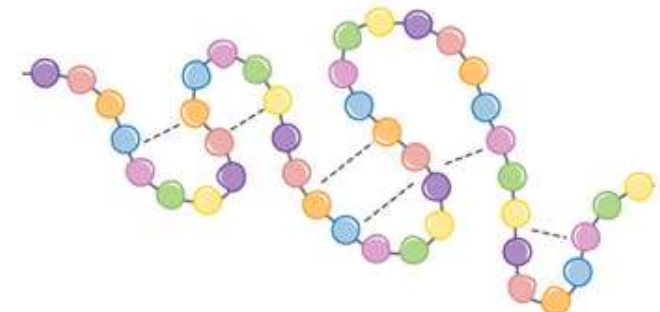
Protein Configuration:

- Four structural level of organization

- Primary , Secondary, Tertiary and quaternary structure.

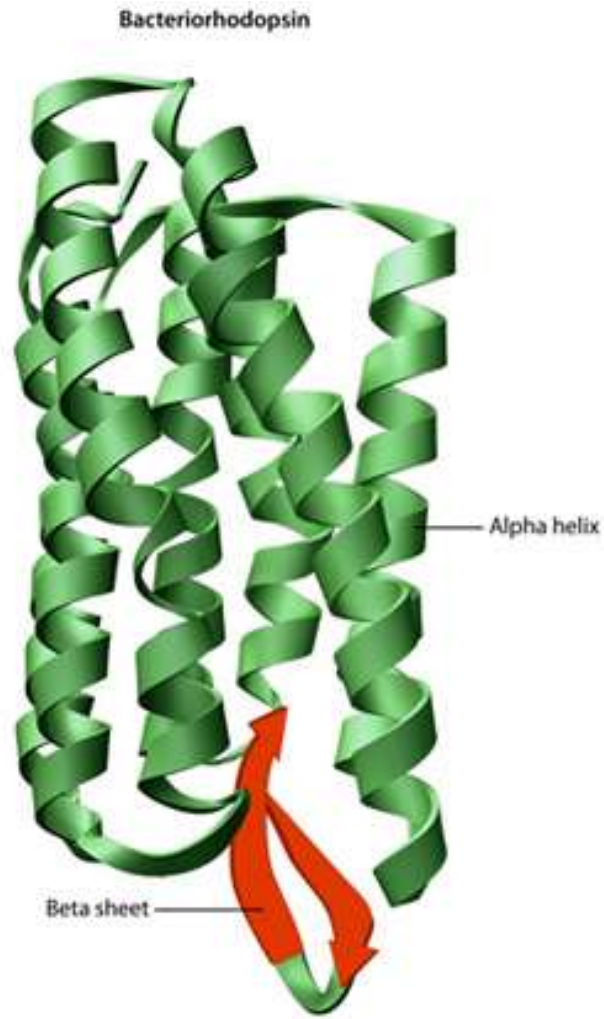

Side chain
Amino group
Carboxyl group

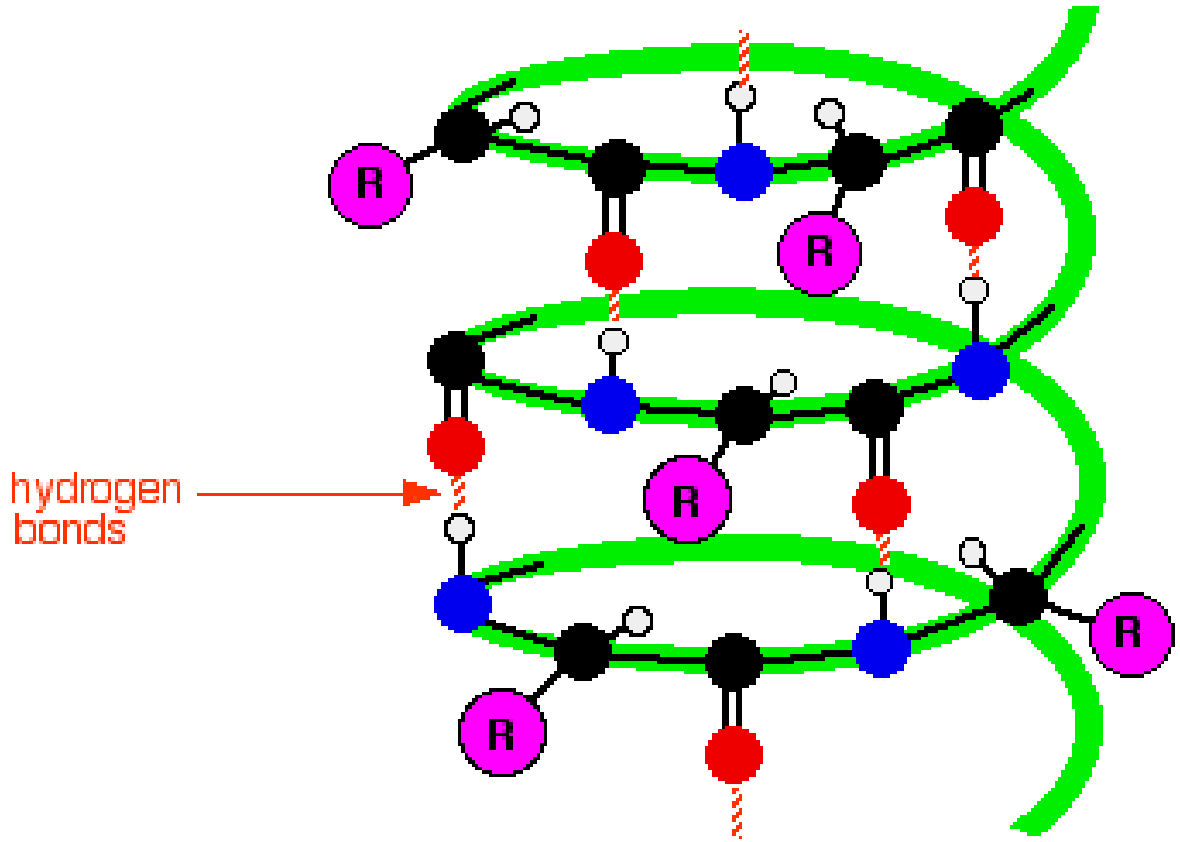

Peptide bond
Amino acid
Amino acid
Amino acid
Amino acid

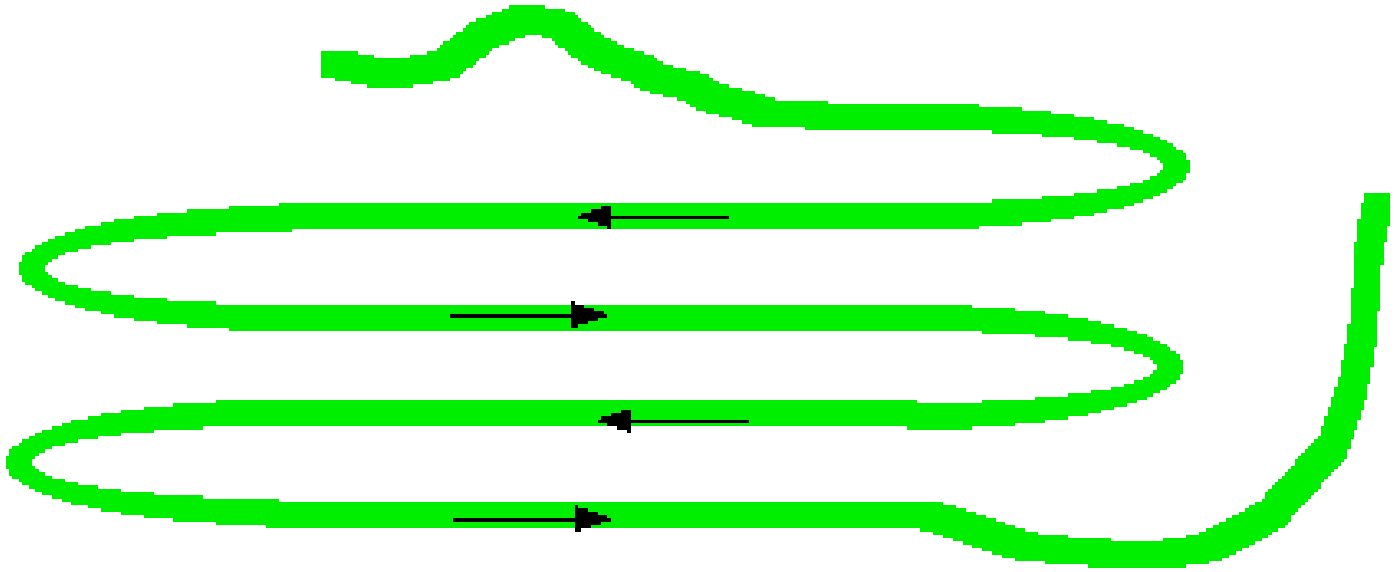


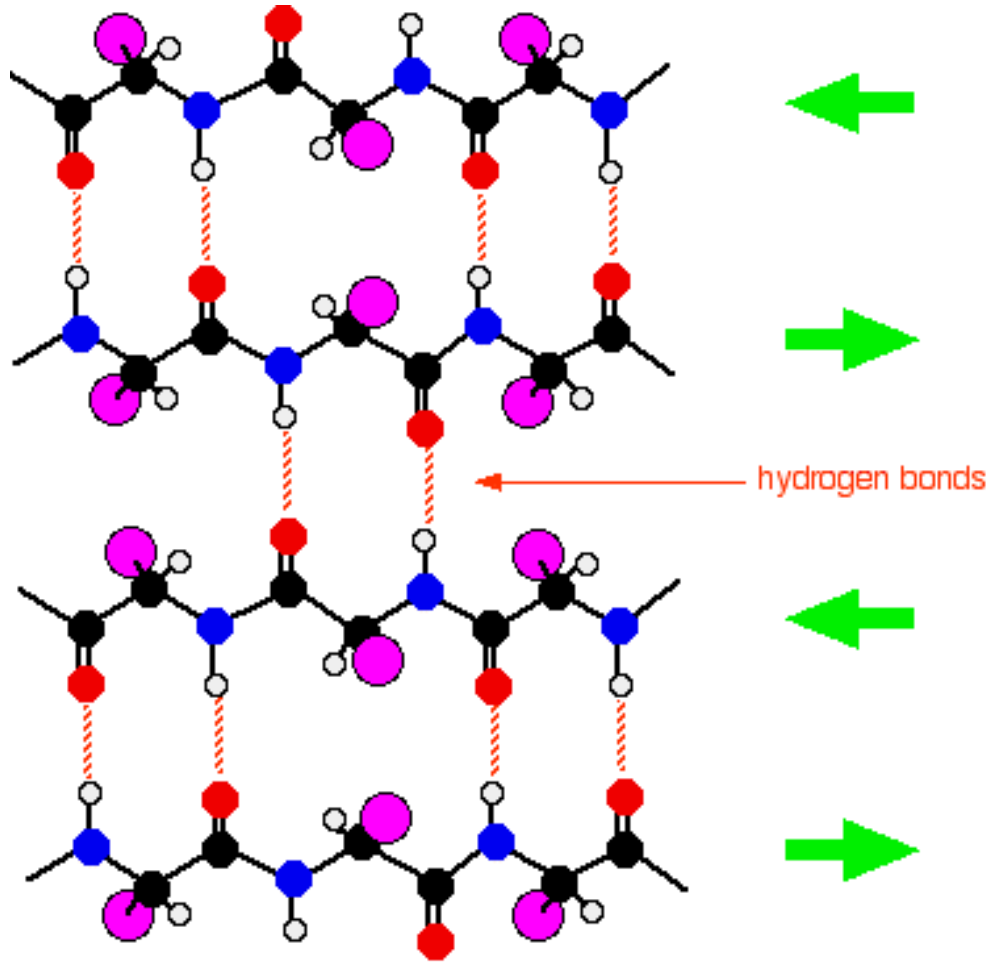
Secondary structure

- Linear chains are organised into regular structures known as alpha-helices (alpha-helixes) and beta-pleated sheets.
- Forms secondary structures in proteins.
- Hydrogen bond between neighboring atoms froms this structure


Bacteriorhodopsin
Alpha helix
Beta sheet


hydrogen
bonds
R
R
R
R
R




hydrogen bonds

Tertiary structure

- Whole chain fold to form 3D structure

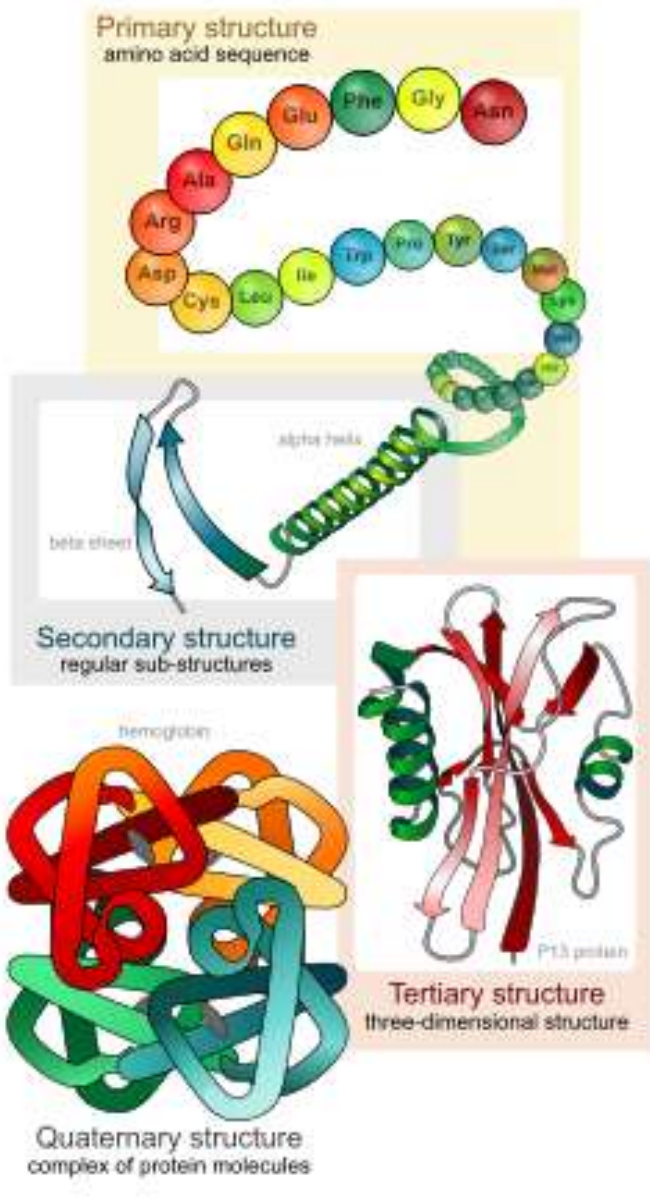
- Tertiary structure of a protein is held together by interactions between the side chains - the "R" groups.

- ***Ionic interactions***
- ***Hydrogen bonds***
- ***Vander walls and sulphur bridges***

Quaternary structure

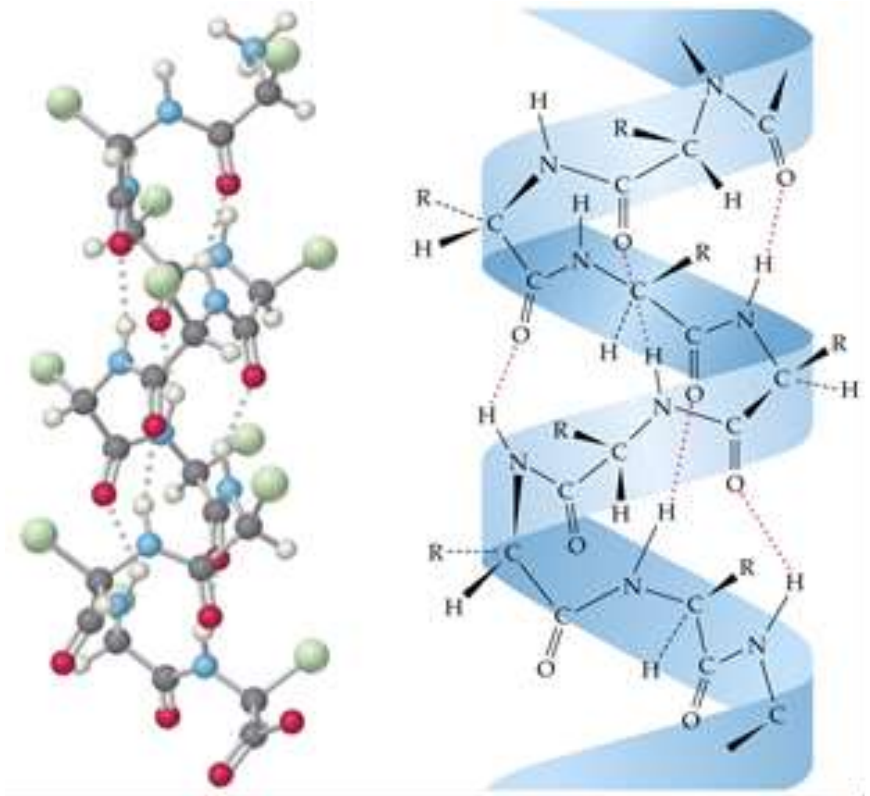
- Structure of a protein macromolecule formed by interactions between multiple polypeptide chains.

- Quaternary structure may consist of more than one of the same type of protein subunit or different.


Primary structure
amino acid sequence
Phe
Gly
Asn
Glu
Gln
Ala
Arg
Asp
Cys
Leu
Ile
Trp
Pro
Tyr
Ser
alpha helix
beta sheet
Secondary structure
regular sub-structures
hemoglobin
Pf3 protein
Tertiary structure
three-dimensional structure
Quaternary structure
complex of protein molecules

Structure and function of keratin

- Fibrous protein, structural layer of epithelial cells

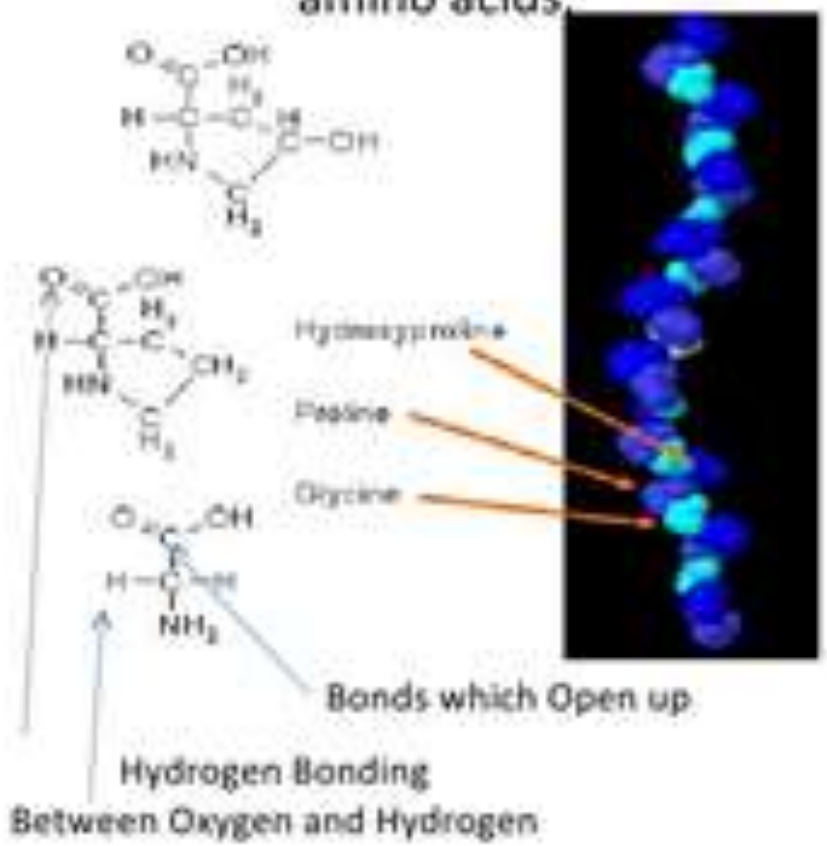


Collagen

- Found in connective tissue, cartilage, bone and tendons
- Twenty eight different types of collagen have been identified in vertebrates.
- Collagen types I to IV are the most prevalent.
- Different tissues of the body contain different amounts of each type of collagen; for example, cartilage contains a lot of type II, whereas type IV is mostly found in basement membranes.

Structure of Collagen

Collagen fibres, with the main amino acids.



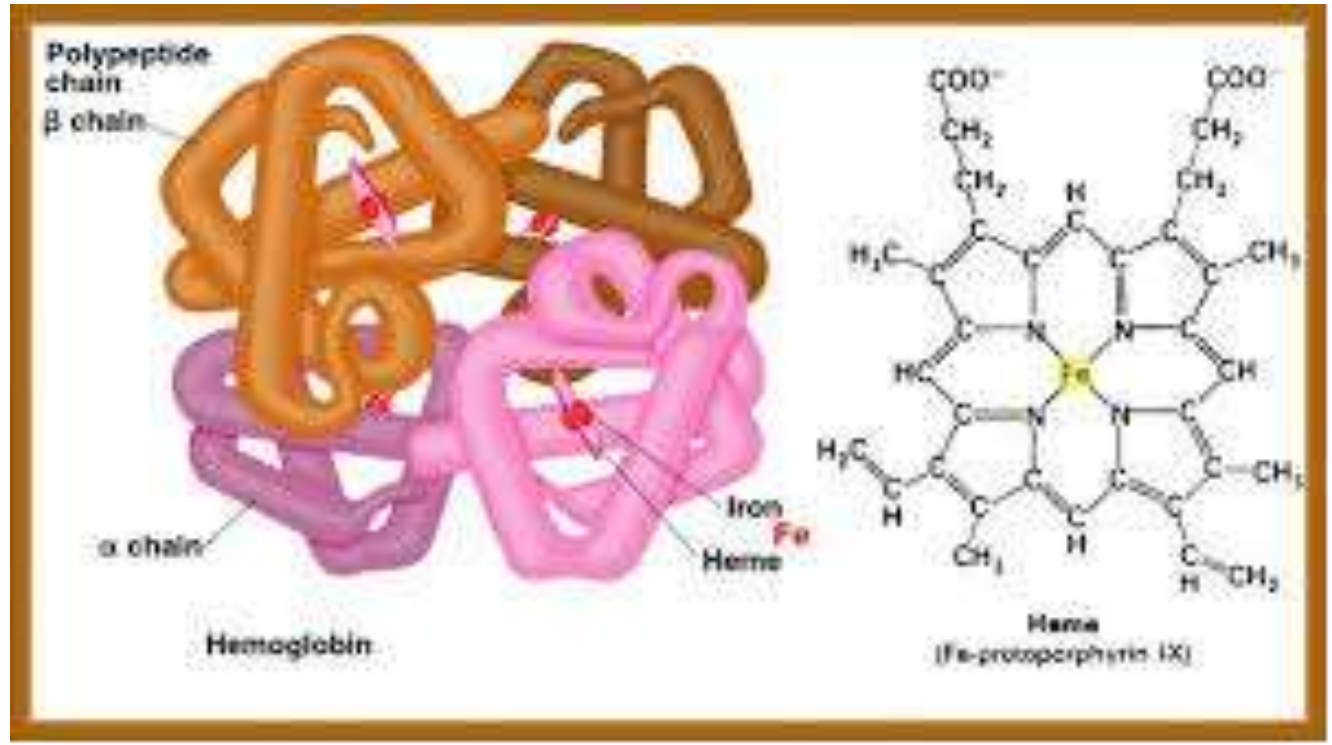
Also, with the structure of the amino acids, which show them in a monomer form but when they become polymers; Hydrogen bonding takes place, between the Oxygen and the Hydrogen.

Elastin:

- Present in connective tissues and allows many tissues in the body to resume their shape after stretching or contracting.

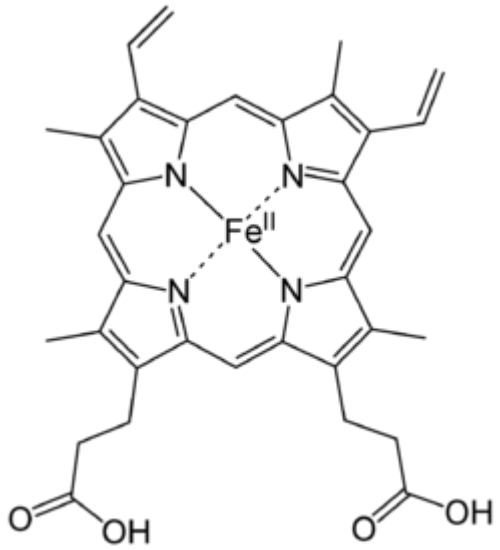
Hemoglobulin:

- Four protein chains: two “alpha chains” and two “beta chains.”
- Each chain contains a central iron atom capable of binding to an oxygen molecule.


Polypeptide chain
β chain
α chain
Iron
Fe
Heme
Hemoglobin
Heme
(Fe-protoporphyrin IX)

Myoglobulin

- Responsible for supply of oxygen to muscles
- Consist of 8 alpha helix connected with oxygen binding site



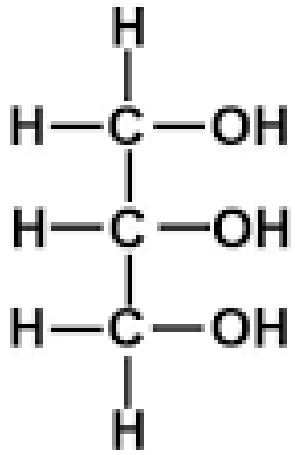
Lipoproteins

- Biochemical assembly of lipid and protein.
- Many enzymes, transporters, structural proteins, antigens, adhesins and toxins are lipoproteins.
- Transmembrane proteins of the mitochondrion and the chloroplast, and bacterial lipoproteins function of lipoprotein.
- **Metalloprotein, Glycoprotein, Nucleoprotein**

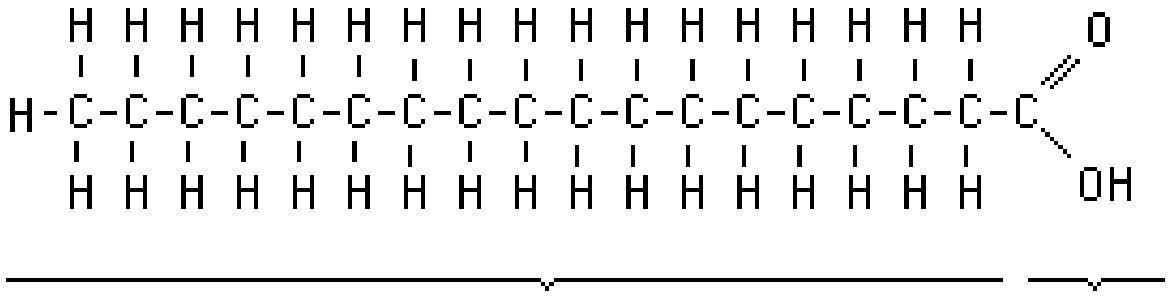
Lipids

- Lipids are defined as esters of glycerol and fatty acids or triglycerides of fatty acids.

- Glycerol is a sugar alcohol, fatty acid is a long chain carboxylic acid 12-22 carbon atoms

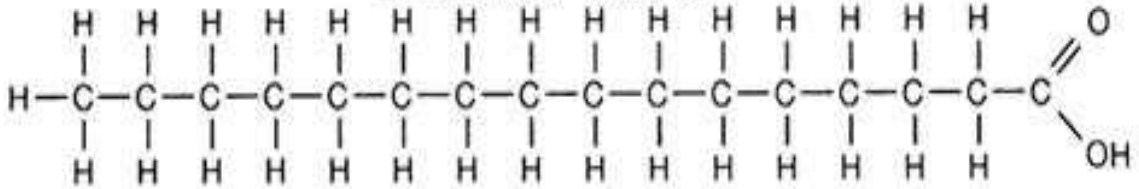


Glycerol

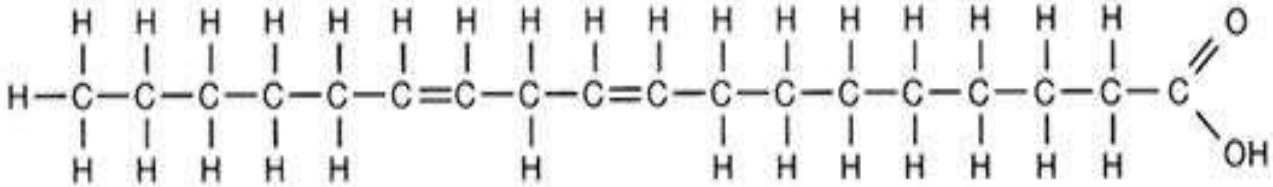


Essential features of a fatty acid

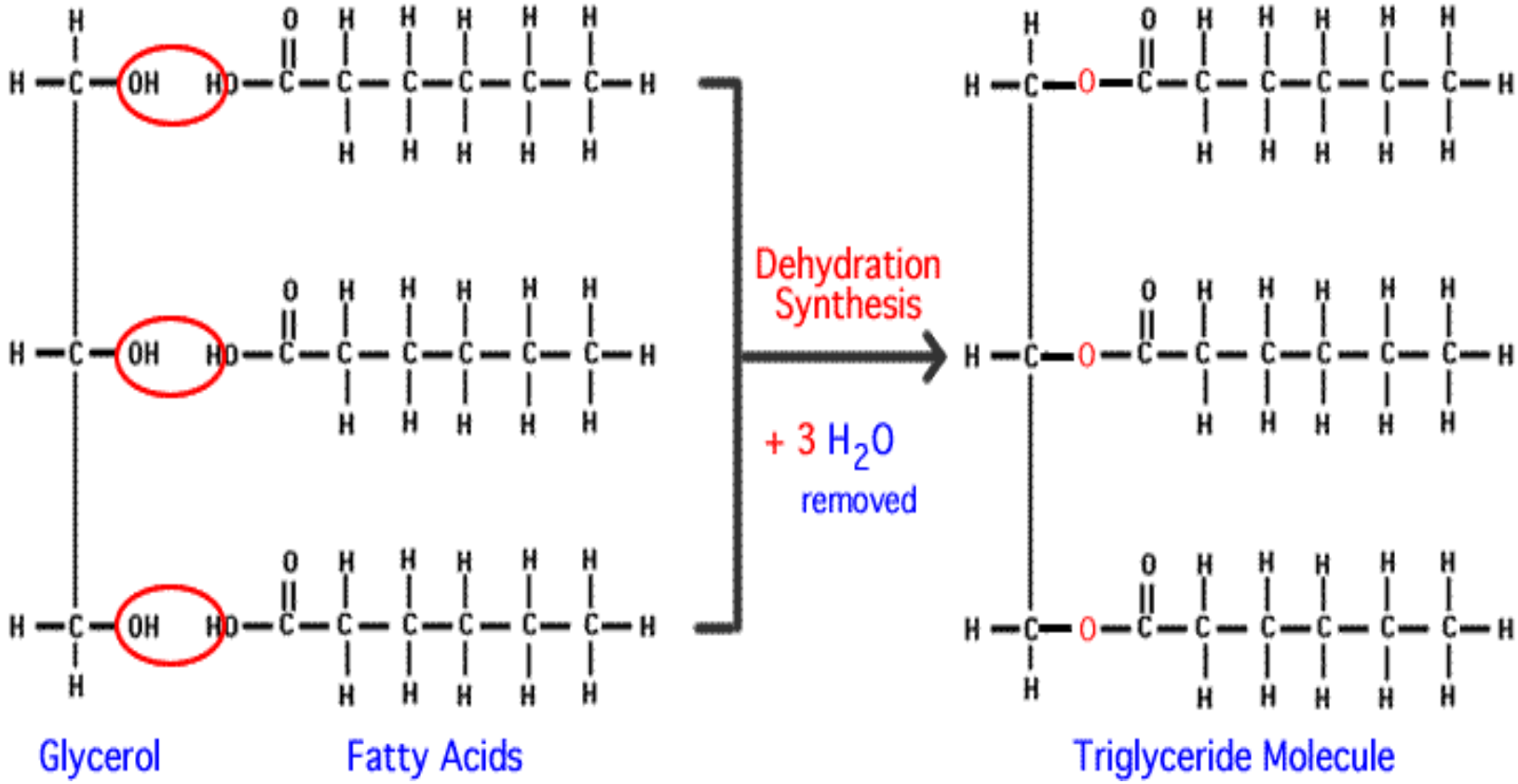
Palmitic acid – saturated



Linoleic acid – unsaturated



The chains may be saturated or unsaturated


Dehydration
Synthesis
+ 3 H_2O
removed
Glycerol
Fatty Acids
Triglyceride Molecule