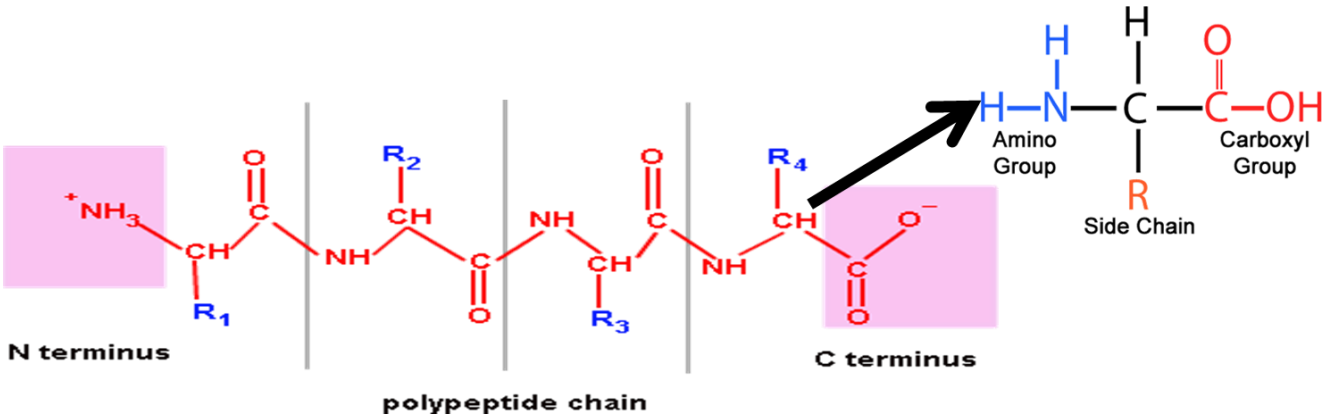
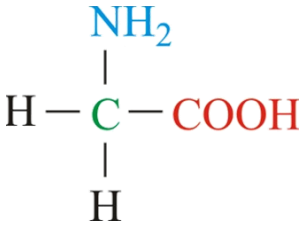
The word "protein" is derived from the Greek word proteios, meaning " first", an indication of the importance of these substances

Proteins are responsible for almost all functions that occur in the body ex. as oxygen transport, as biological catalysts (enzymes), regulate metabolic processes (hormones)

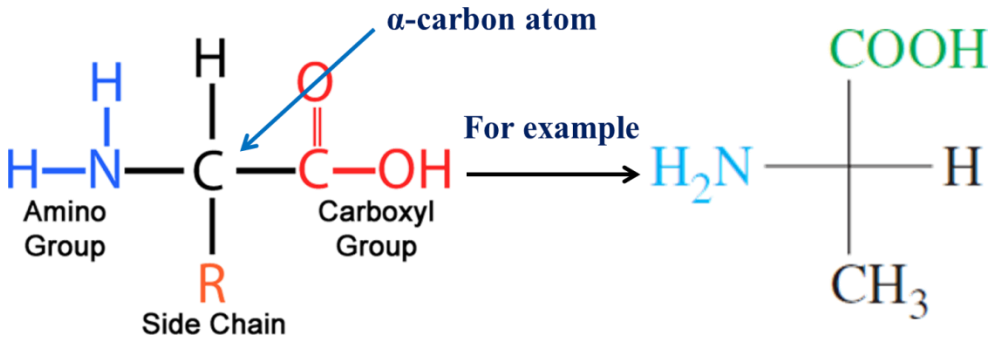
Proteins are composed of linear biopolymers of amino acids (the monomeric unit of proteins) held together by peptide bonds.



The term amino acid that mean any molecule containing both an amino group and any type of acid group; however, the term is almost always used to refer to an carboxylic acid. The simplest acid is aminoacetic acid, called glycine.



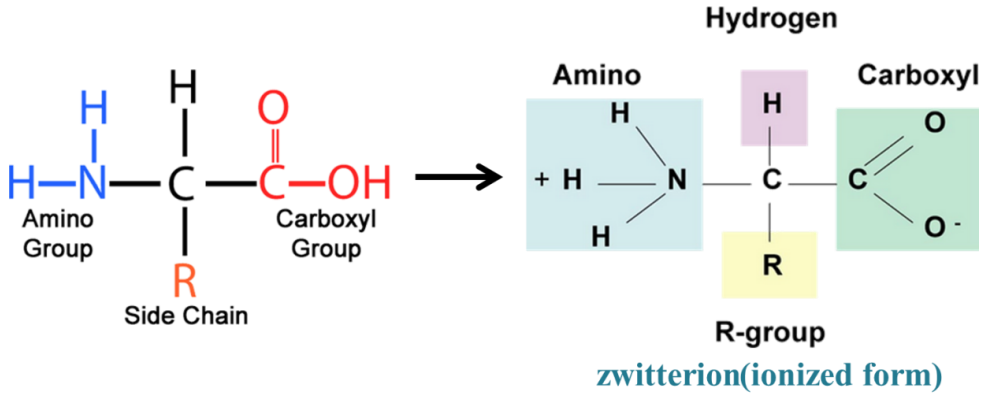
Other common amino acids have side chains (symbolized by R) substituted on the α-carbon atom.



Ionization of Amino Acids

In most body fluids the carboxylic group (−COOH) and the amino group (−NH2) are ionized.

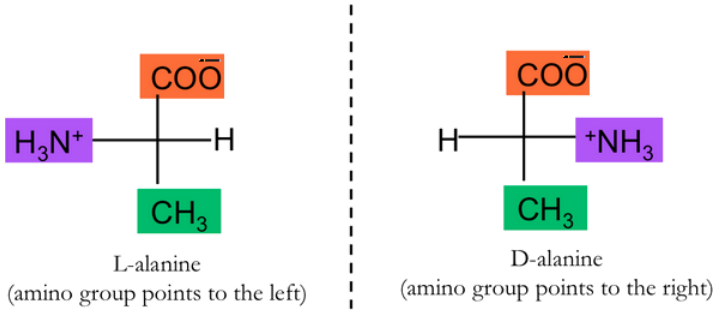
An ionized amino acid that has a positive and negative charge is a dipolar ion called a zwitterion.



Fischer Projections of Amino Acids

Except for glycine, the acids are all chiral. In all of the chiral amino acids, the chirality center is the asymmetric α carbon atom.

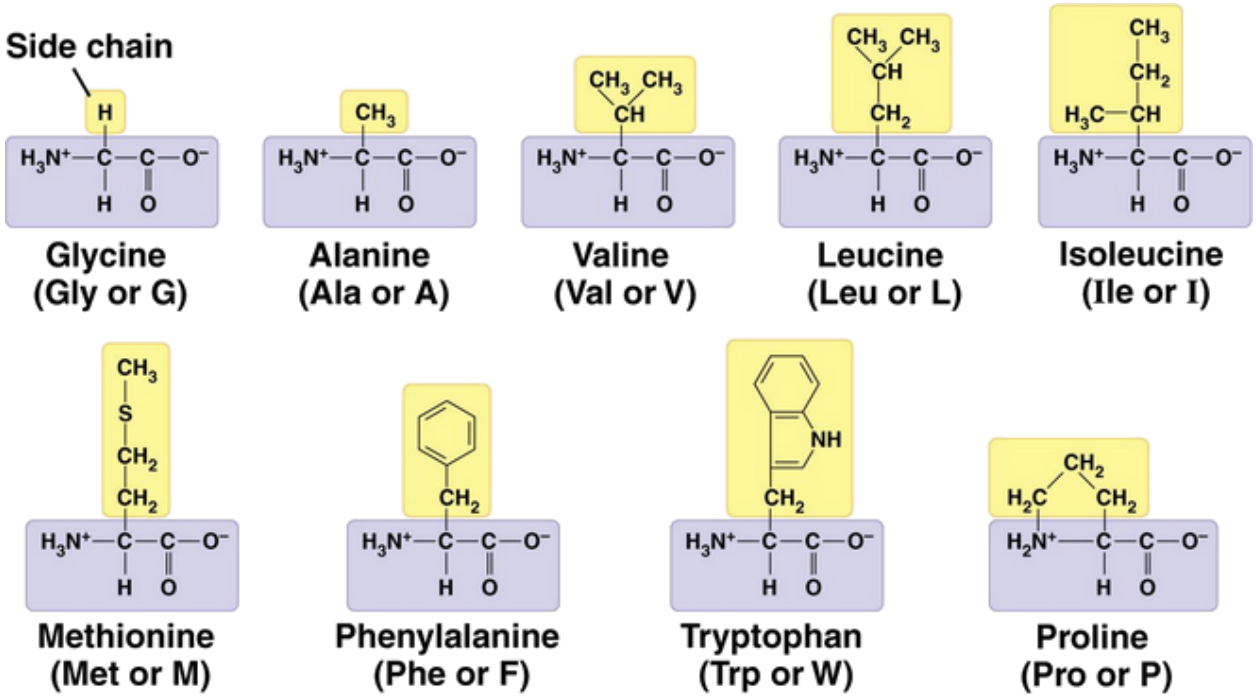
Amino Acids have Fischer projections that are stereoisomers, with the carboxylate group at the top, R (side chain) group at the bottom, when amino group on the left , is called as L isomers but when amino group on the right , is called as D isomers



Classification of Amino Acids

Amino acids can be classified as

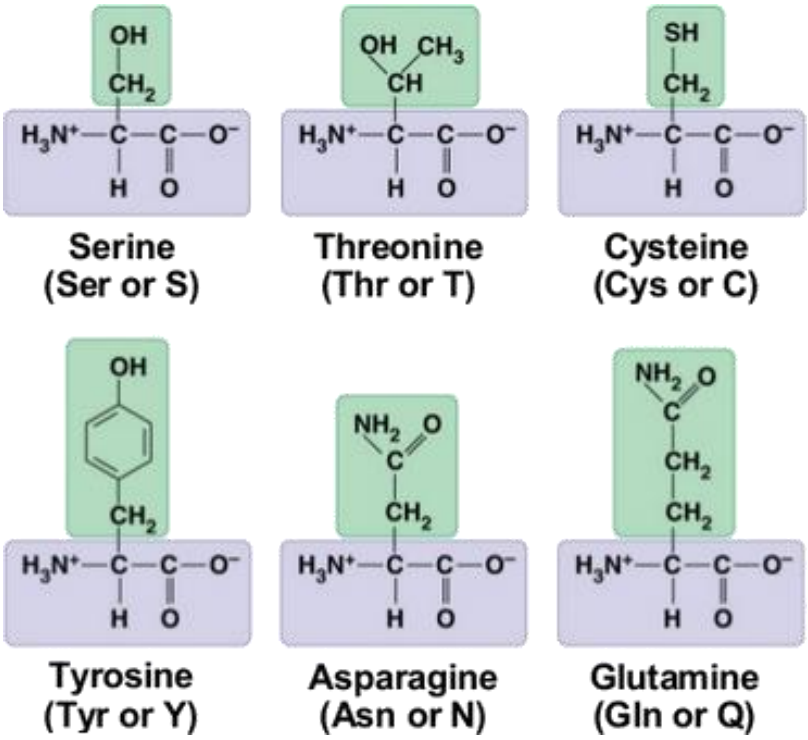
1-nonpolar (hydrophobic) with hydrocarbon side chains



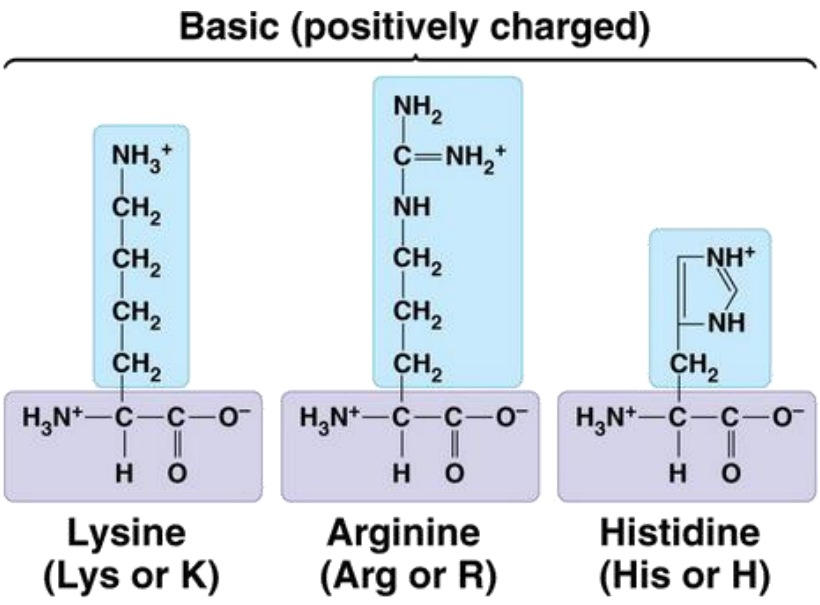
2-polar (hydrophilic) with polar or ionic side chains

A-Polar and no charged Amino Acids

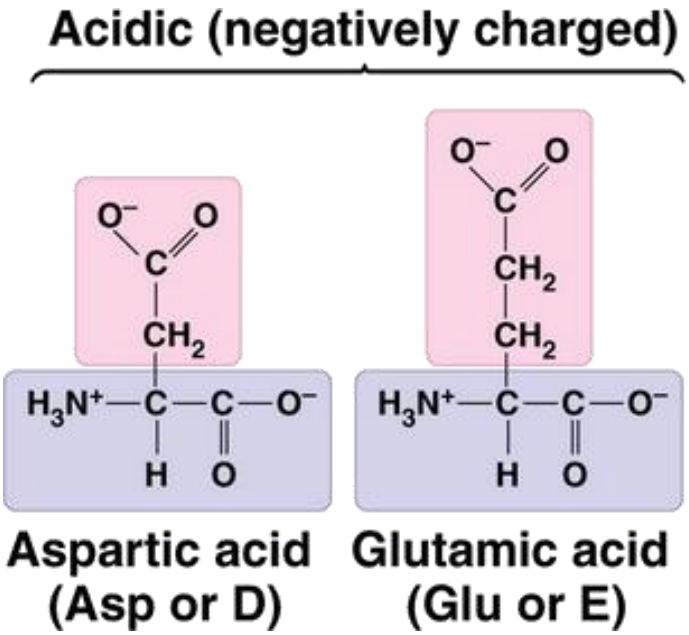
An amino acid is polar when the R group is an alcohol, thiol, or amide.



B-Polar and basic charged Amino Acids

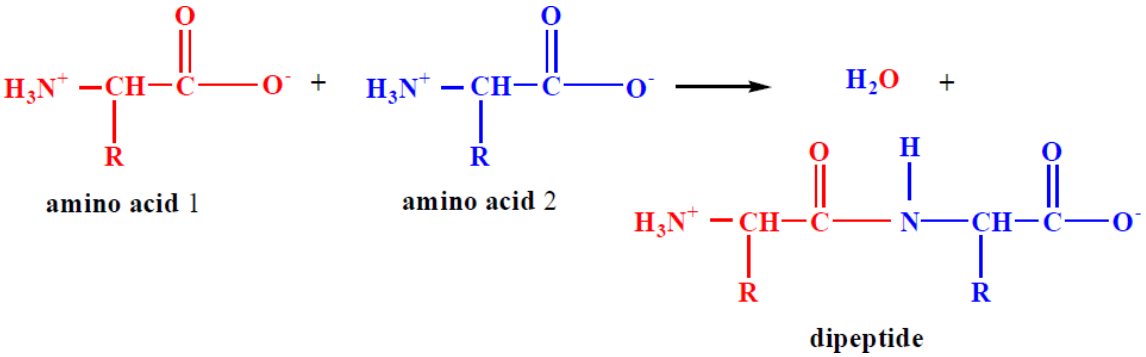


C-Polar and acidic charged Amino Acids

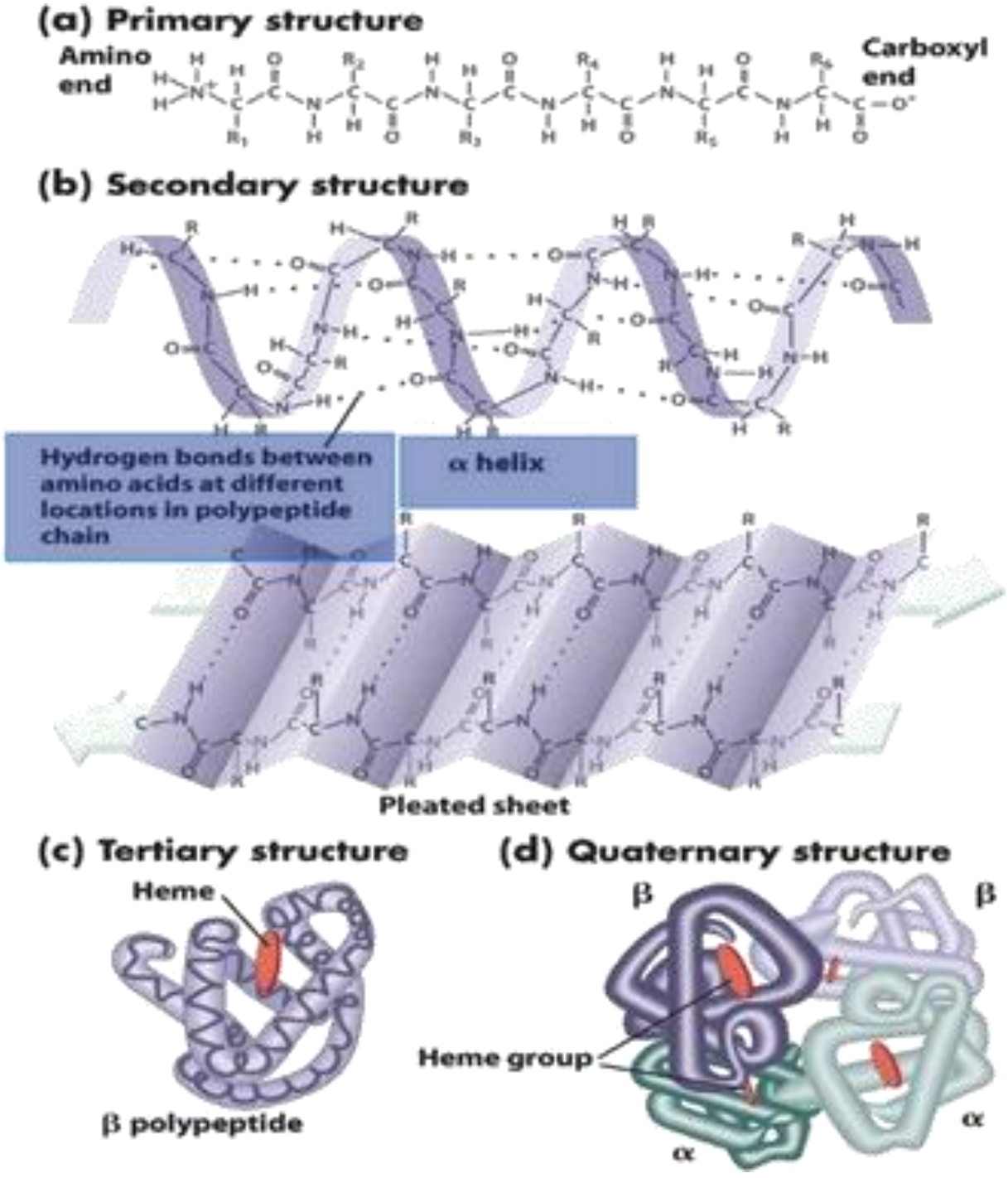


Individual amino acids in a protein molecule are linked by peptide bonds. A peptide bond forms when a carboxylic acid from one amino acid reacts with the amino group of another amino acid. Peptide bond is the name that biochemists give to the amide bond.

Proteins are synthesized from 20 amino acids. All of the amino acids except proline have a α-carbon atoms

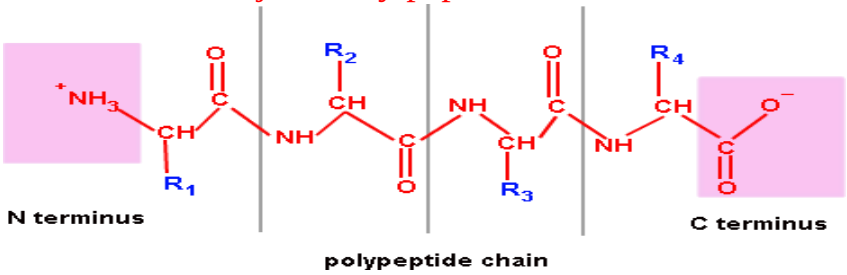


STRUCTURE OF PROTEIN



Primary structure

The primary structure is defined as the polypeptide backbone, which is made up of a unique sequence of amino acids joined by peptide bonds



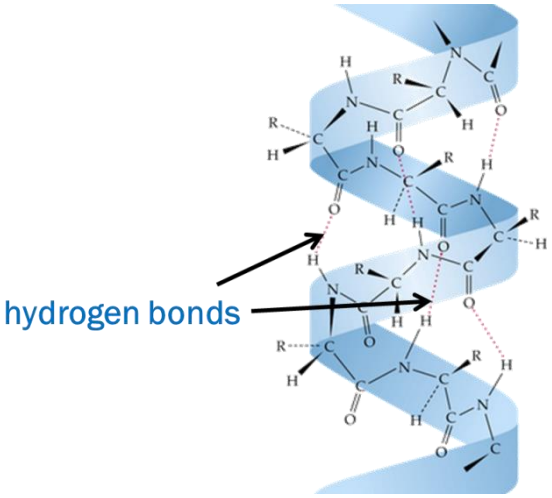
Secondary structure

The formation of hydrogen bonds between the carbonyl oxygen of one peptide bond and the amide hydrogen of another peptide bond gives rise to repeating patterns of secondary structure

The most common types of secondary structure found in proteins are α-helix, β-structures, and β-bends

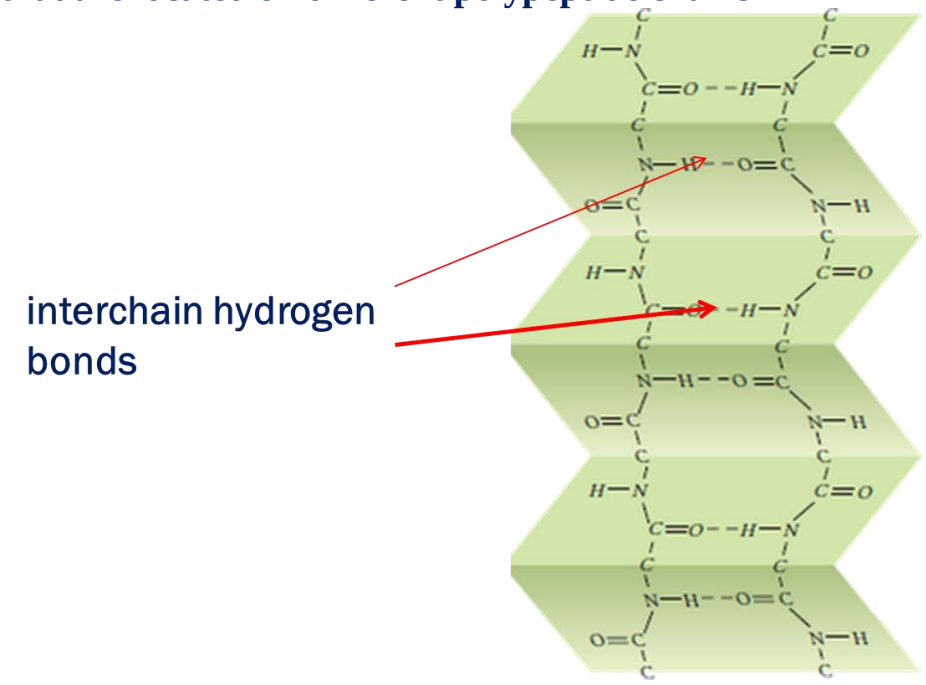
α -Helix

α-helix are stabilized by intrachain hydrogen bonds that are formed between the carbonyl oxygen of one peptide bond and the amide hydrogen of amino acids located four residues in the linear sequence.



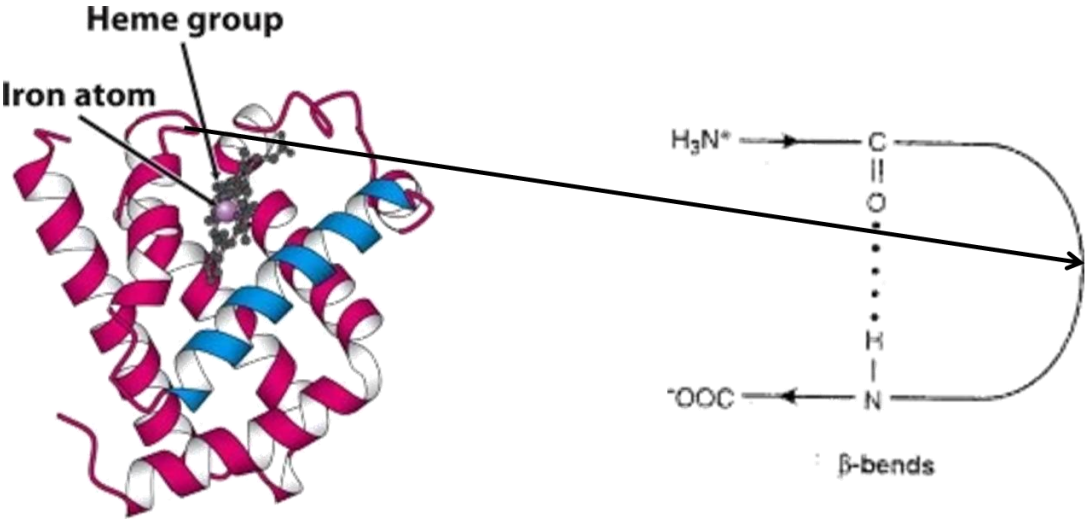
β-structures

β-structures somtime called β-sheet or β-barrel, are stabilized by interchain hydrogen bonds between the carbonyl oxygen and the amide hydrogen atoms that are located on different polypeptide chains



β-bends

A third types of secondary structure is β-bends which reverses the direction of the polypeptide chain in globular proteins. β-bends are stabilized by hydrogen bonds between the first and the fourth amino acid residue in the bend.



The tertiary structure

The tertiary structure describes the overall three-dimentional structure of a protein. It is stabilized by a large number of noncovavelent interaction side chains of amino acids (except disulfide bonds)

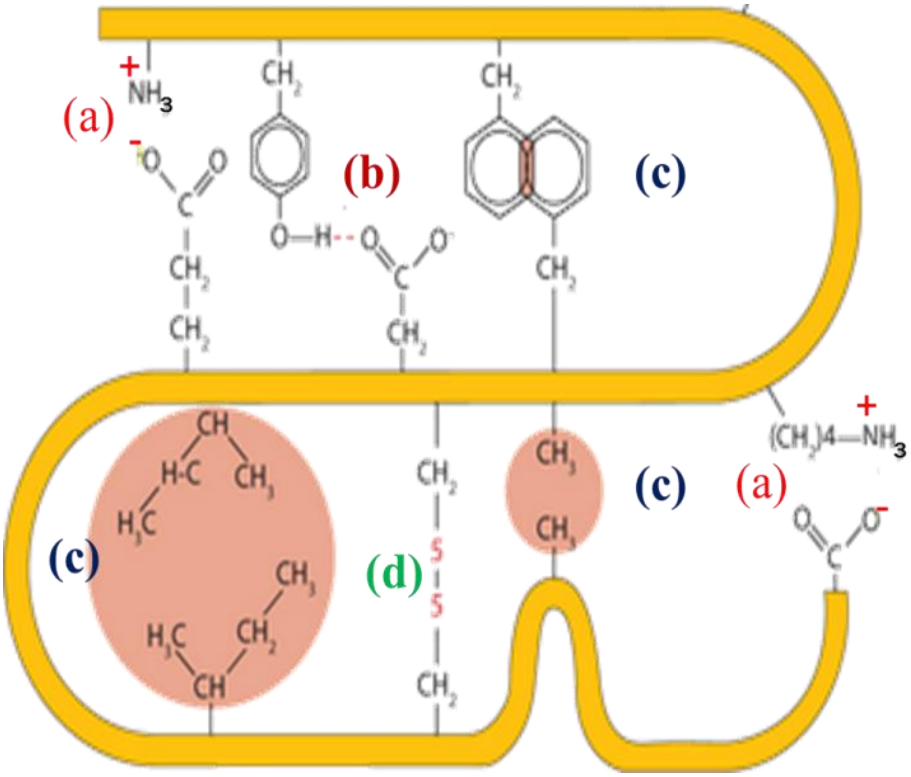
stabilizing force include

a- ionic interaction

b-hydrogen bonds

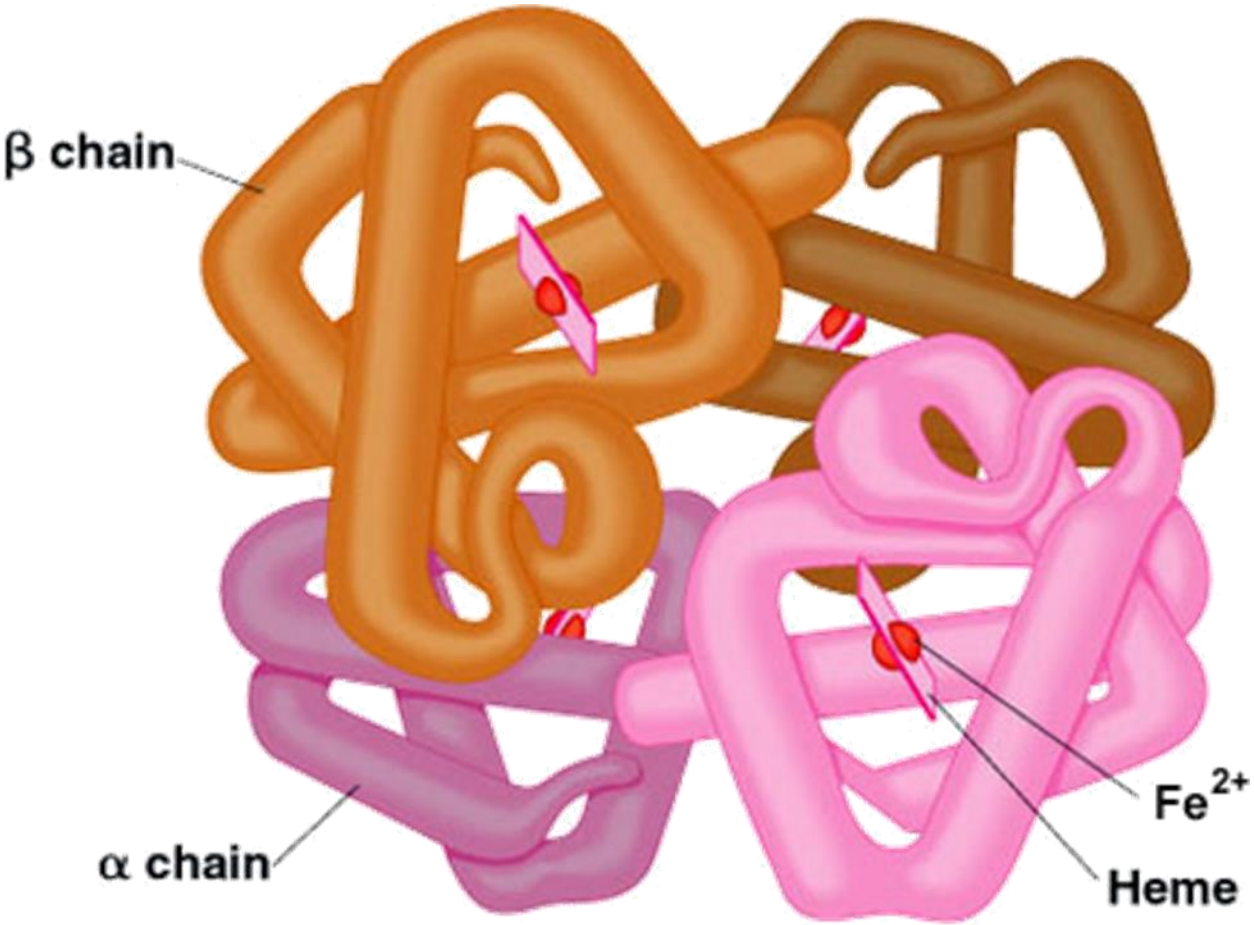
c- hydrophobic interactions

d-disulfide bonds

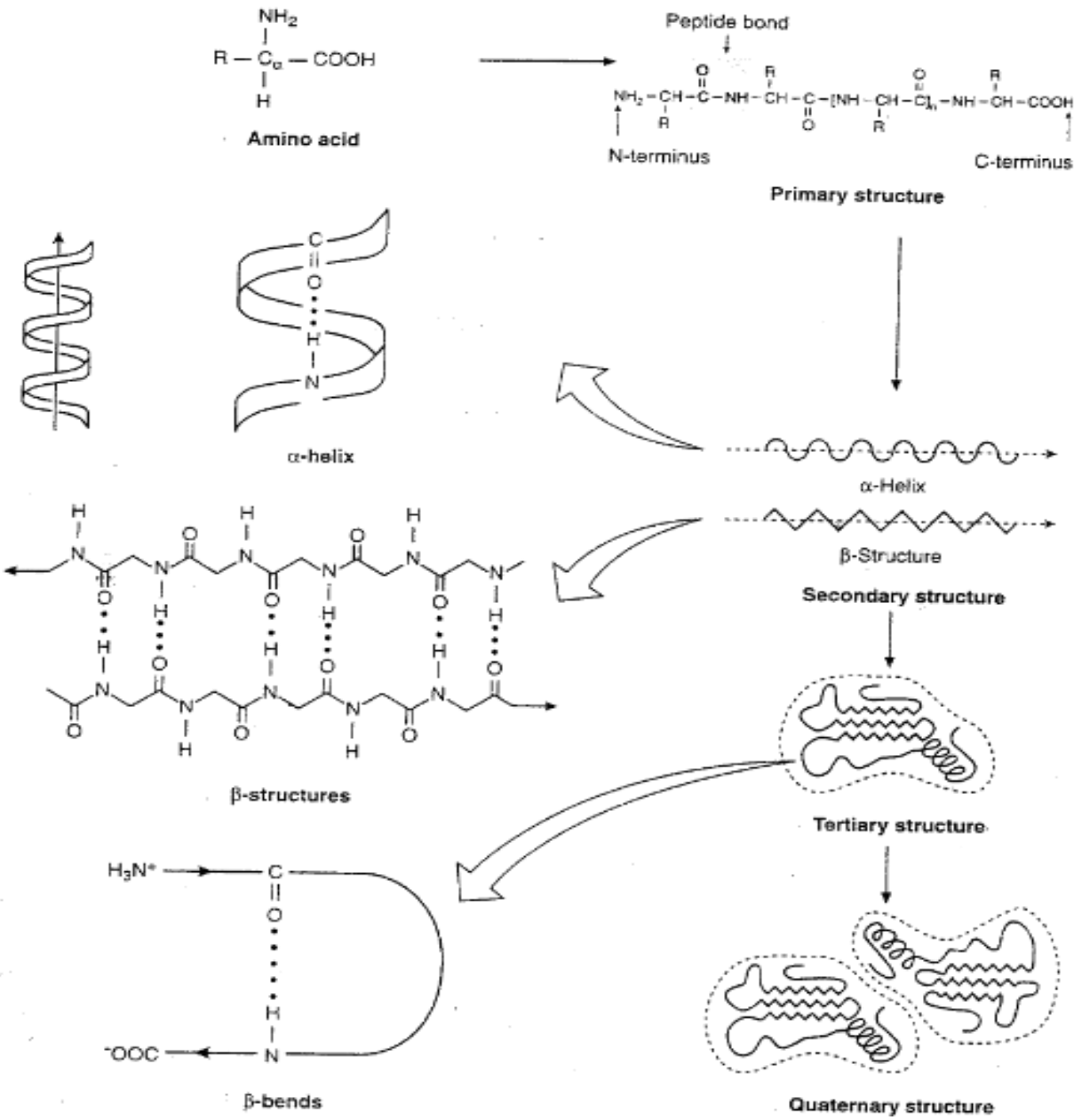


Quaternary structure

protein that consist of more than one subunit (polypeptide chain) have quaternary structure. The subunit are held together by the same types of noncovelent interaction that stabilized The tertiary structure



Summary


Amino acid
Peptide bond
N-terminus
C-terminus
Primary structure
α-helix
α-Helix
β-Structure
Secondary structure
β-structures
Tertiary structure
β-bends
Quaternary structure

CLASSIFICATION BASED ON THE SHAPE OF PROTEIN MOLECULE

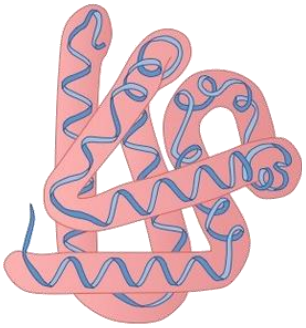
On the basis of the shape of protein molecule, the proteins have been grouped under two types : globular and fibrous.

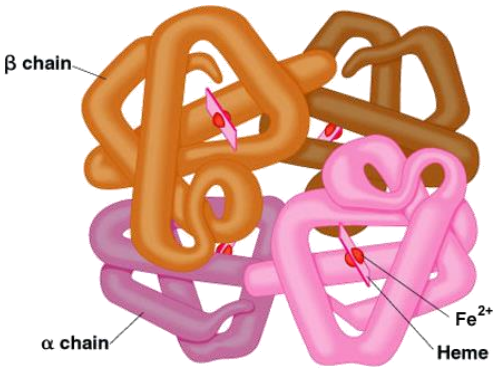
1. Globular Proteins.(spheroproteins)

A - have possess a relatively spherical or ovoid shape.

B - soluble in water or in aqueous media containing(acid)

C-Tertiary and quaternary structures





2. Fibrous Proteins.

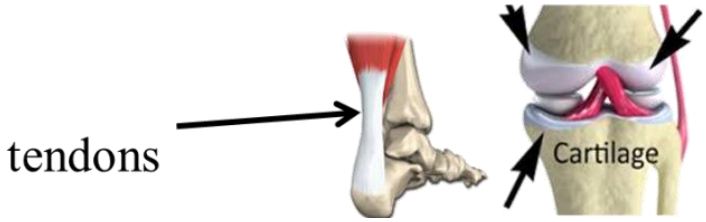
A- A Fibrous protein is a protein with an elongated shape.

B- insoluble in all common solvents

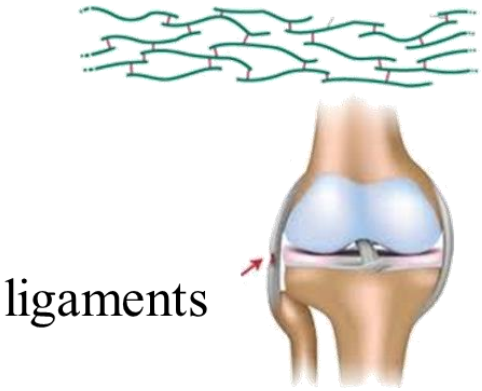
C- serve in a structural or protective role.

They have types:

A-Collagens. : they form the major proteins of white connective tissues (tendons, cartilage) of bone.



B-Elastins: they form the major constituents of yellow elastic tissues (ligaments, blood vessels). Elastin functions in connective tissue together with collagen



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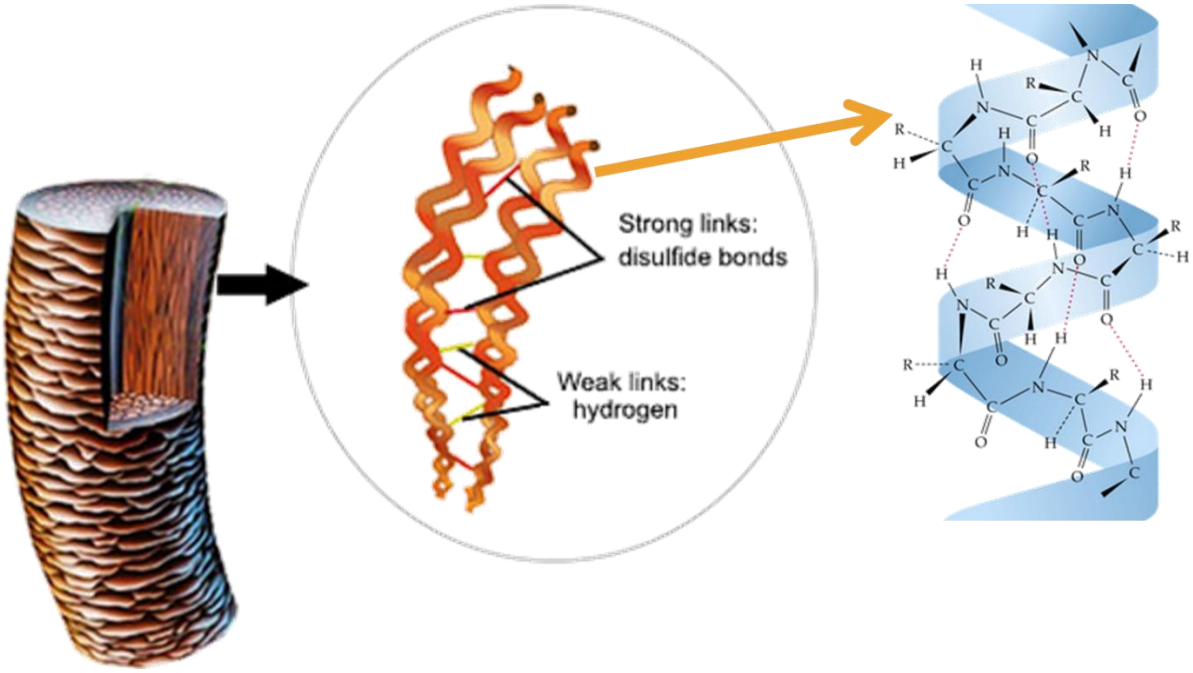
C- Keratins.: they form the major constituents of epithelial tissues (skin, hair, feathers, horns, hoofs, nails); *usually contain large amounts of sulfur because the structure come from alpha helices that are cross-linked by disulfide bonds.*



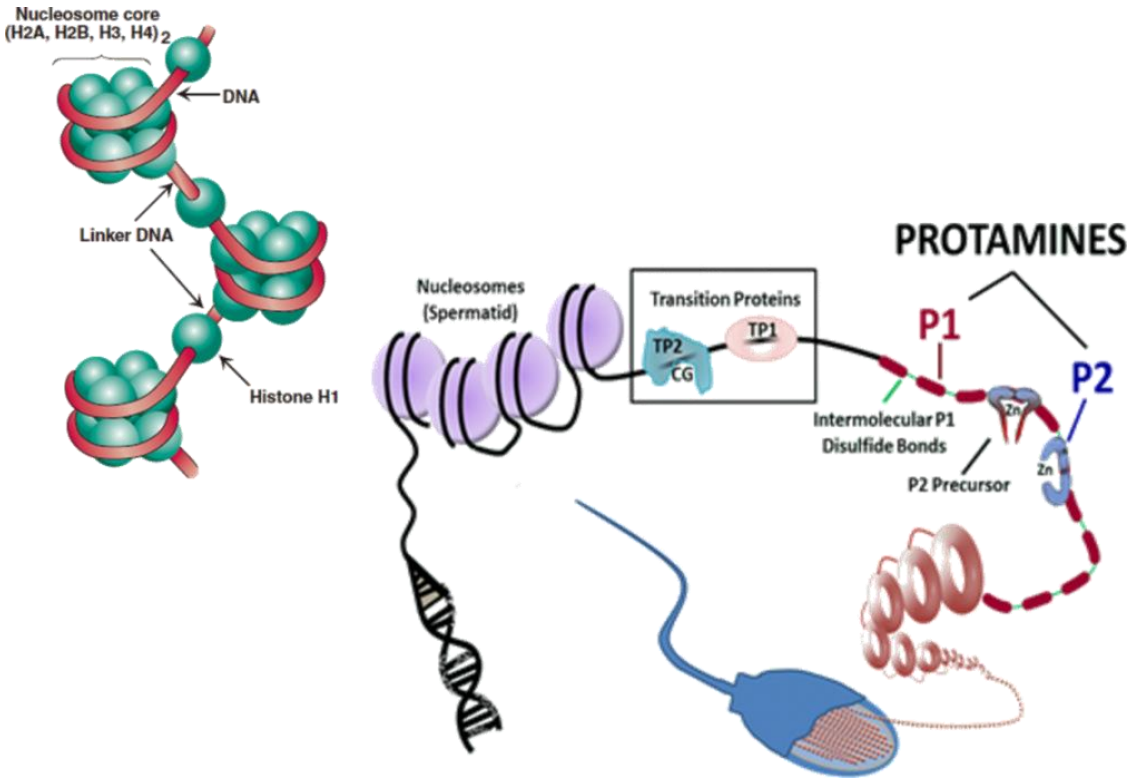
CLASSIFICATION BASED ON COMPOSITION

A. Simple Proteins or Holoproteins.

These are of globular type except for scleroproteins. This group includes proteins containing only amino acids.

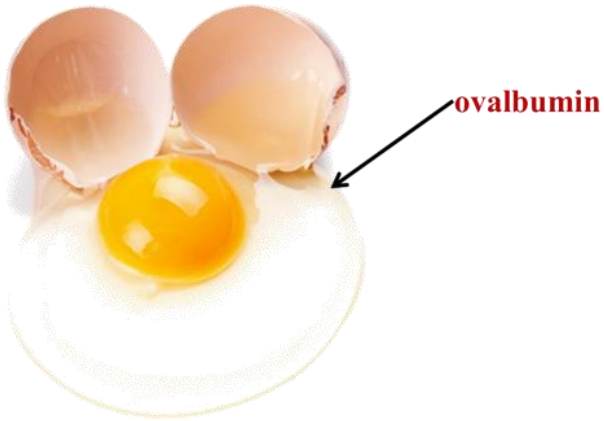
1. **Protamines and histones.**

are basic proteins (high content of basic amino acids (lysine, arginine)) found in sperm cells, not coagulated by heat; strongly basic example nucleic proteins.



2. Albumins.

These are produced by the liver and helps in transportation of different components in blood (drugs). Albumins also help to maintain water balance in the body and contribute to osmotic pressure and coagulated by heat. Example serum albumin from blood plasma, myosin of muscles . ovalbumin from white of egg



3. Globulins.

A-Globulins serve as antibodies and transport substances

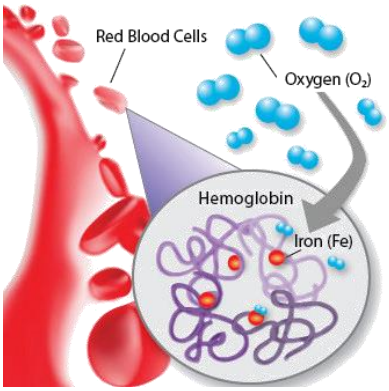
B-The globulins are of three types called alpha, beta, and gamma globulins.

4-Scleroproteins These occur almost in animals '*animal skeleton proteins*'; insoluble in water, (*collagen*, *elastin*, *keratin*).

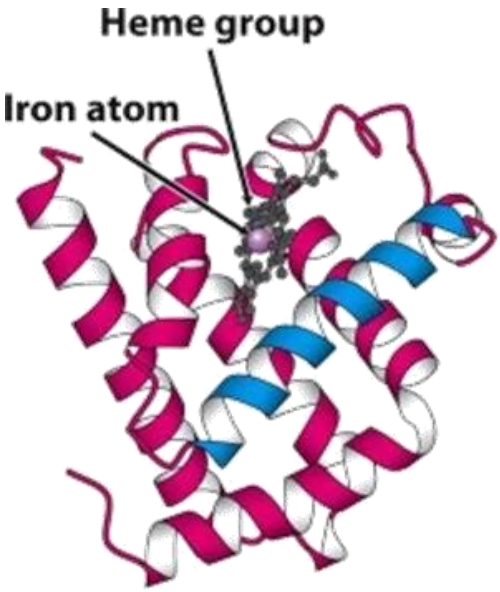
B. Conjugated or Complex Proteins or Heteroproteins.

These are the proteins linked with non protein portion called prosthetic group. The prosthetic group may be either a metal or a compound. On decomposition with acids to result amino acids as well as the prosthetic group.

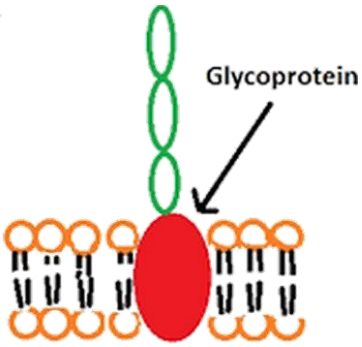
Metalloproteins. These are the proteins linked with various metals.. Based on their reactivity with metal ions, Hemoglobin.



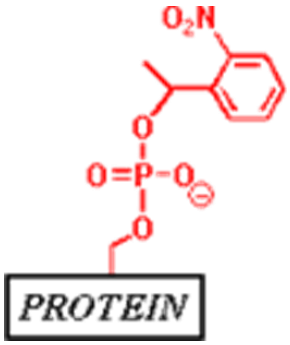
Chromoproteins. These are proteins coupled with a coloured pigment. Such pigments have also been found among the enzymes like catalase, peroxidase and flavoenzymes



2.Glycoproteins and Mucoproteins. These are the proteins containing carbohydrate as prosthetic group. Glycoproteins contain small amounts of carbohydrates (less than 4%), whereas mucoproteins higher amounts (more than 4%).

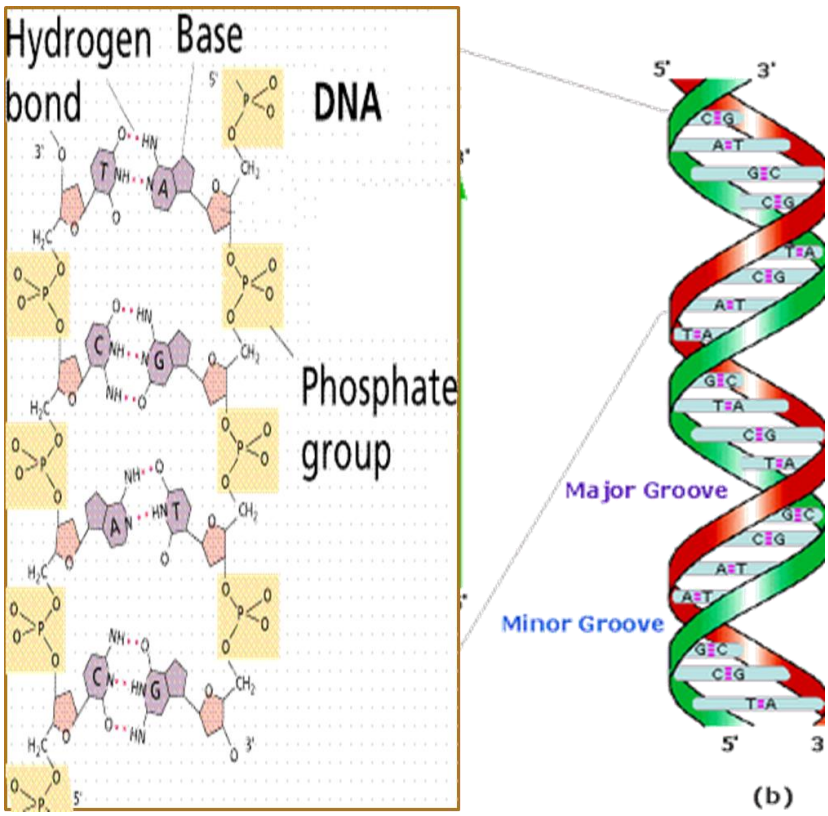


4. Phosphoproteins. These are proteins linked with phosphoric acid; mainly acidic. *e.g., casein* from milk and *ovovitellin* from egg yolk.



5.Lipoproteins. Proteins forming complexes with lipids (cephalin, lecithin, cholesterol) are called lipoproteins; soluble in water but insoluble in organic solvents

6. Nucleoproteins. These are compounds containing nucleic acid and protein(protamines and histones). These are usually the salt-like compounds of proteins (Nucleic acid has negative charge and protamines have positive charge).



B. Conjugated or Complex Proteins or Heteroproteins

Example for conjugated proteins	*Nonprotein part present + protein*
Hemoglobin (Hb)	Heme + globin
Nucleoprotein	DNA + histone
Lipoprotein	Lipids + apolipoprotein
Phosphoprotein (Casein)	Phosphate + protein
Glycoprotein (egg albumin)	Carbohydrate + protein
Ferritin	Iron + apoferritin

CLASSIFICATION BASED ON SOLUBILITY

Class	*Soluble in*	*Example*
Albumins	Water	Serum albumin, egg albumin
Globulins	Dilute salt solutions	Serum globulins
Histones (Basic proteins)	Dilute acids	Nucleoproteins, histones
Scleroproteins	Insoluble in H_2O	Collagen, elastin

CLASSIFICATION BASED ON BIOLOGICAL FUNCTION

Biological role	*Proteins*	*Function*
Structural proteins	Collagen keratins	Bone and hair respectively
Enzymes	Pepsin, amylase	Help in digestion of food
Hormones	Insulin, prolactin	Regulate the metabolism
Transport proteins	Hemoglobin (Hb)	Transport of oxygen
Protein receptor	Hormone receptor	Insulin receptor on liver cell
Storage proteins	Ferritin	Storage form of iron in liver
Immune proteins	γ-globulins	Act against antigens
Contractile proteins	Actin, myosin	Muscle contraction
Buffering proteins	Plasma protein and Hb	Maintains the pH of blood

Essential and nonessential

1-All tissues in our body are capable of synthesizing amino acids, but the major sources for newly synthesized amino acids are the liver and (to a lesser extent) the intestines

2- Nine amino acids cannot be synthesized by our body at all, and must therefore be obtained from the diet. These amino acids are referred to as 'essential'.

3- The remaining 6 amino acids, termed 'conditionally essential', can be synthesized, but need to be supplemented from the diet under certain conditions or situations (e.g. when the body is growing or ill).

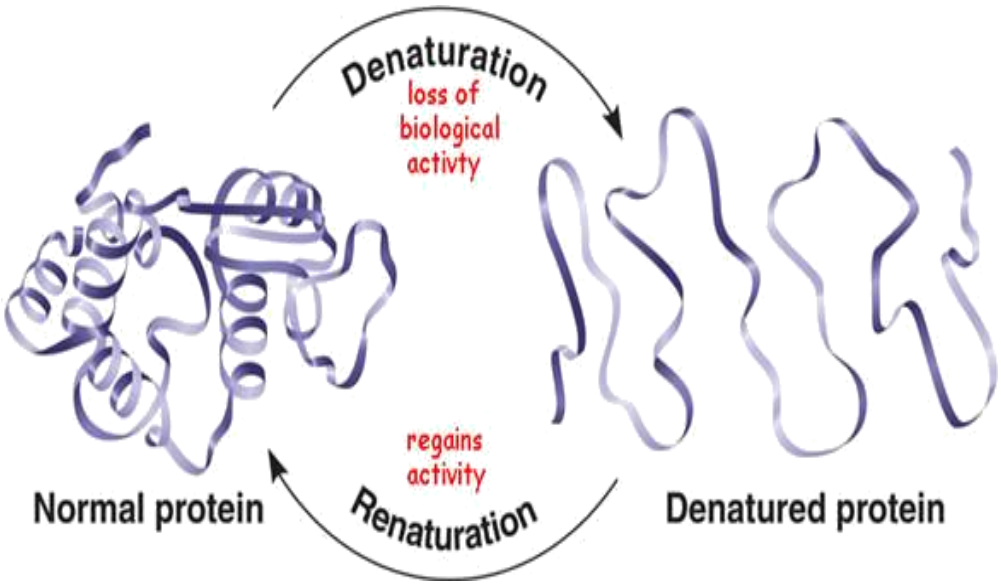
Both (all 20 AA) are equally needed and equally essential for the normal growth and good health.

Nonessential and Essential Amino Acids for Humans and the Albino Rat		
Nonessential	**Conditionally essential**	**Essential**
Alanine	Arginine	Histidine
Asparagine	Cysteine	Isoleucine
Aspartate	Glutamine	Leucine
Glutamate	Glycine	Lysine
Serine	Proline	Methionine
	Tyrosine	Phenylalanine
		Threonine
		Tryptophan
		Valine

Denaturation of protein

Denaturation of the proteins is a condition when the unique three-dimensional structure of a protein is exposed to changes. Due to changes in temperature, pH or other chemical activities, the hydrogen bonds present in the proteins get disturbed

Protein denaturation results in the unfolding and disorganization of the protein's secondary and tertiary structures, which are not accompanied by hydrolysis of peptide bonds



PROTEIN

The end product of digestion: amino acids

• Stomach: Digestion begins in the stomach. The enzyme pepsin breaks large protein chains into smaller chains called proteoses, peptones, and polypeptides.

O Protein digestion begins in the stomach with the enzyme pepsin.

O It is secreted by the chief cells of the gastric glands in the form of pepsinogen.

O HCL helps convert pepsinogen into the active enzyme pepsin

Digests less than 15% of ingested protein

• Small Intestine:

O Pancreas: Secretes enzymes (trypsin, chymotrypsin and carboxypolypeptidase) **into small intestine. These enzymes act on the small chain proteins.**

O Additional enzymes are secreted by the small intestines.

O The small chain proteins are converted into amino acids.

large amino acid chain ⟶ small amino acid chain ⟶ individual amino acids

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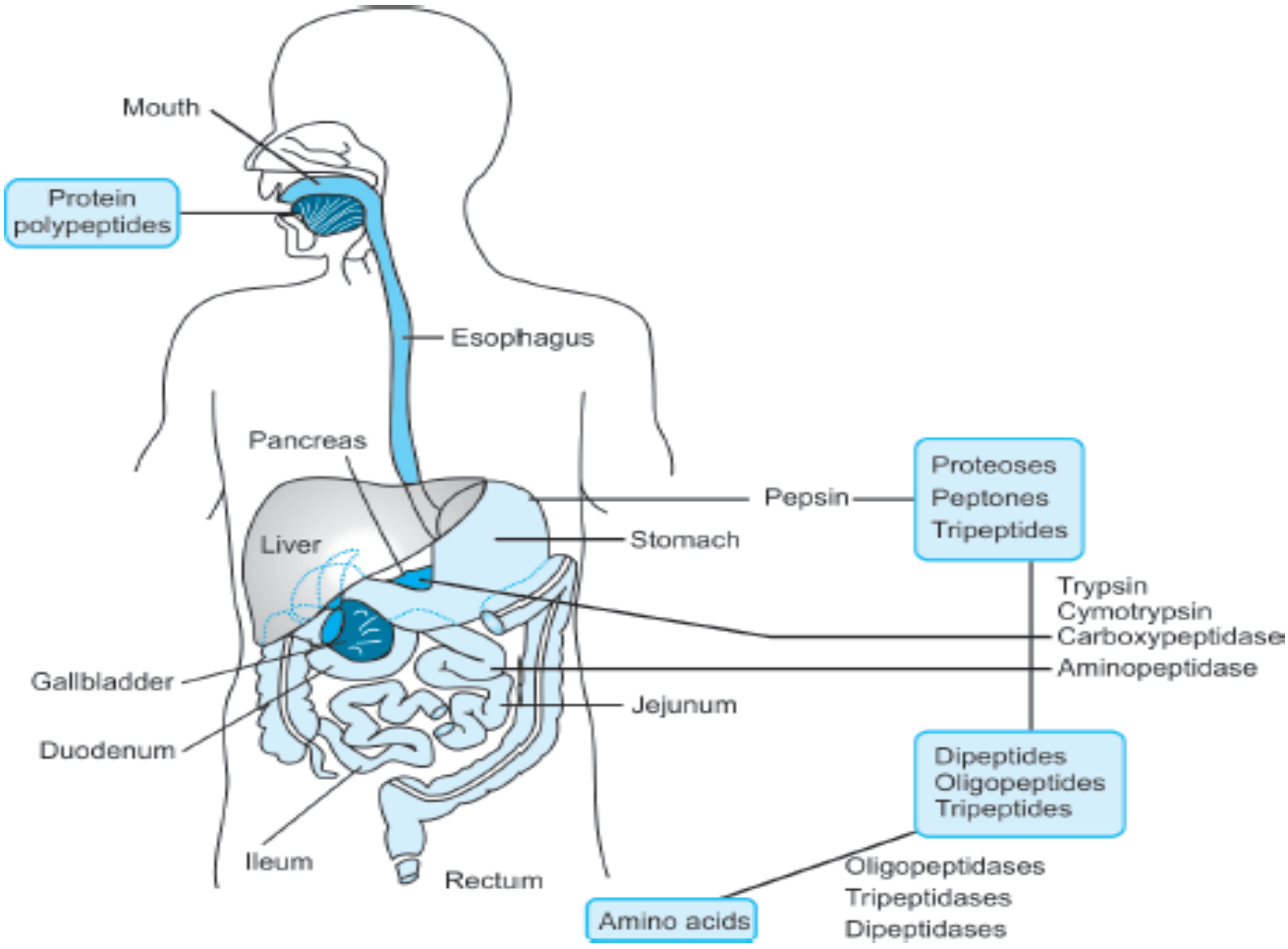
Mouth
Protein polypeptides
Esophagus
Pancreas
Liver
Stomach
Pepsin
Proteoses
Peptones
Tripeptides
Trypsin
Cymotrypsin
Carboxypeptidase
Aminopeptidase
Gallbladder
Duodenum
Jejunum
Dipeptides
Oligopeptides
Tripeptides
Ileum
Rectum
Amino acids
Oligopeptidases
Tripeptidases
Dipeptidases