UNIT I
BIOMOLECULES

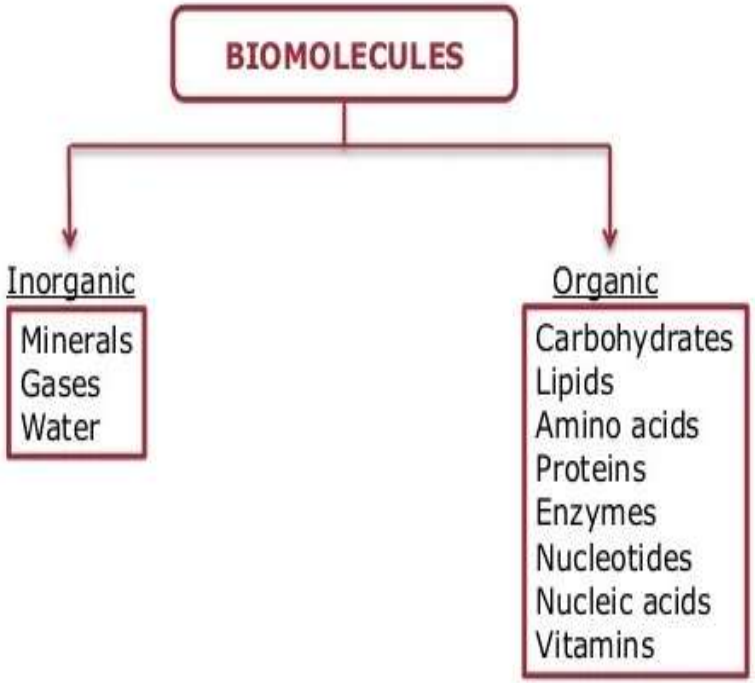
Biochemistry definition

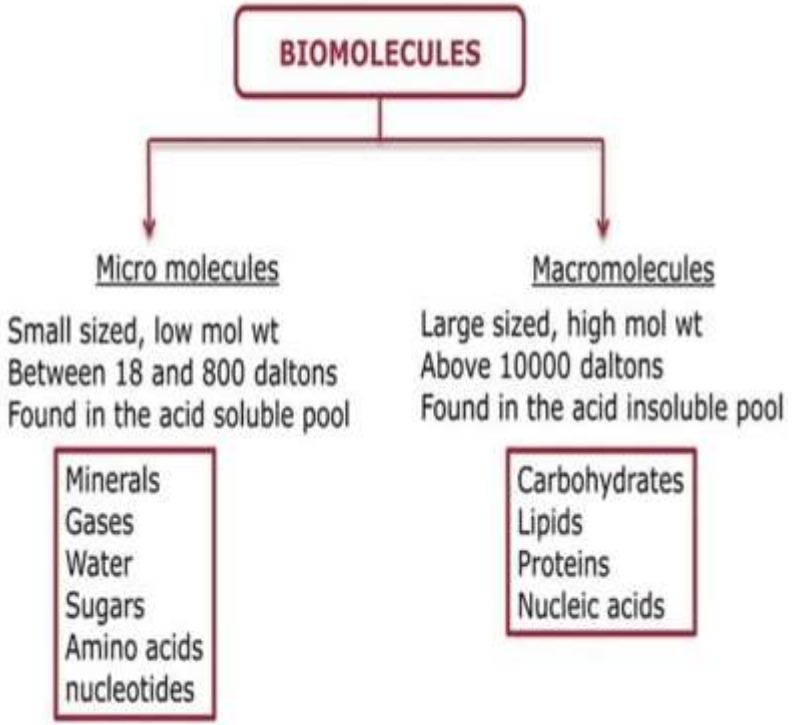
- Biochemistry is the study of the chemical reactions that take place inside living organisms.
- It can also be described as the science concerned with the chemical constituents of living cells and with the reactions and processes they undergo.
- eg. Reactions occurs during digestion, Conversion of food into energy.

Biomolecules

- Biomolecules are the molecules present in a living organisms.
- These molecules are fundamental building blocks of living organisms as they support the biological processes essential for life.
- Biomolecules include macromolecules like proteins, carbohydrates, lipids and nucleic acids.
- It also includes small molecules like primary and secondary metabolites and natural products.
- Biomolecules consists mainly of carbon and hydrogen with nitrogen, oxygen, sulphur and phosphorus.
- Biomolecules are very large molecules of many atoms, which are covalently bound together.
- The cellular pool is the collection of diverse types of biomolecules, chemicals and ions present in a cell. It contains both organic and inorganic molecules and is present in two phases aqueous and non aqueous phases.
- The acid soluble pool refers to a group of **small organic molecules** found in living cells. These molecules are soluble in acidic solutions. It have a molecular weight ranging from **18 to 800 Daltons (Da)**. Eg. Amino acids, simple sugars (saccharides).

Classification of biomolecules





Cellular pool

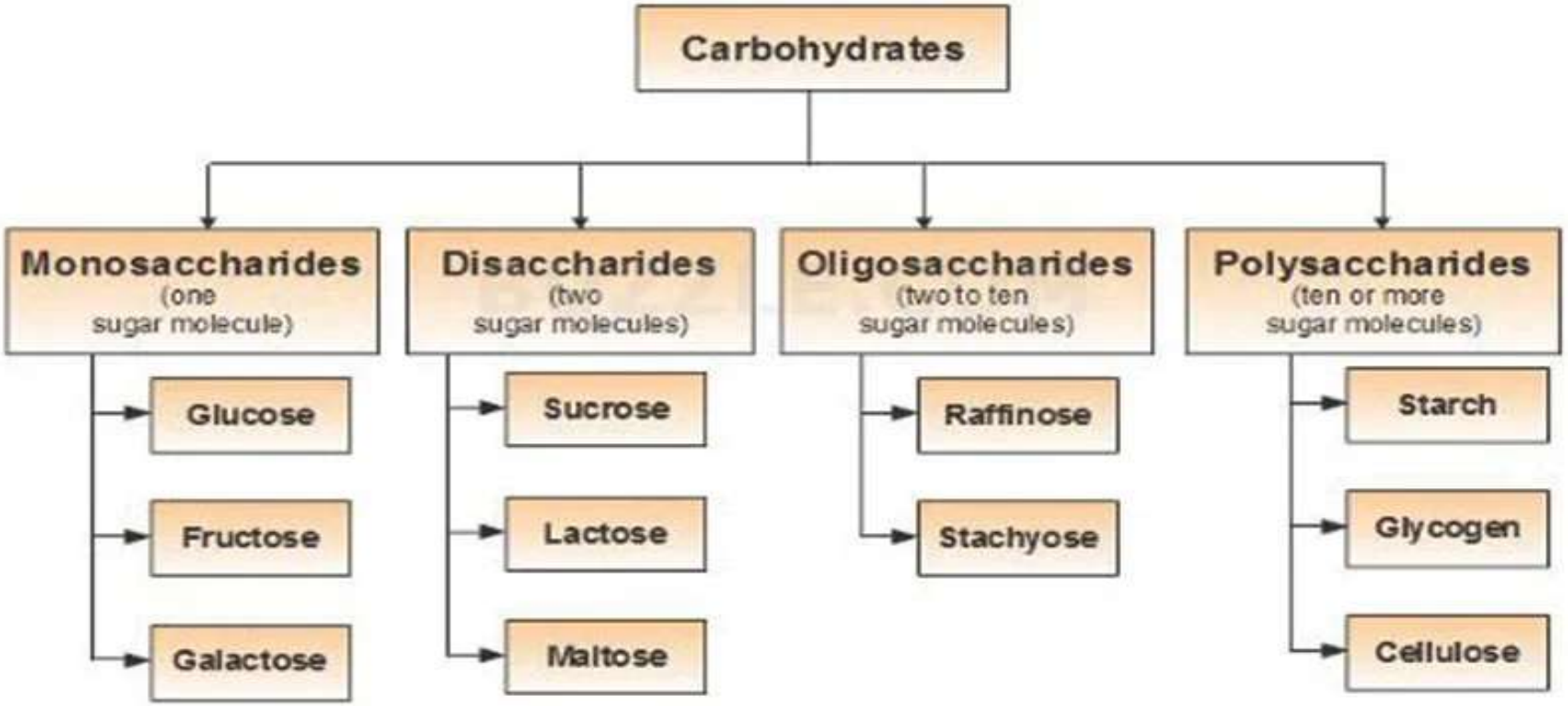
- The cellular pool is the collection of diverse types of biomolecules, chemicals and ions present in a cell. It contains both organic and inorganic molecules and is present in two phases aqueous and non aqueous phases.
- The acid soluble pool refers to a group of **small organic molecules** found in living cells. These molecules are soluble in acidic solutions. It have a molecular weight ranging from **18 to 800 Daltons (Da)**. Eg. Amino acids, simple sugars (saccharides).
- The acid insoluble pool refers to a group of **large organic molecules** found in living cells. These molecules are insoluble in acidic solutions. It have a high molecular weight. Eg. Proteins, polysaccharides.

Carbohydrates

- Carbohydrates are organic compounds with general formula $C_n(H_2O)_n$. They are composed of carbon, hydrogen and oxygen.
- They are regarded as hydrates of carbon, but structurally they show resemblance with polyhydroxy aldehydes or ketones.
- Carbohydrates are primary source of energy as cells utilise carbohydrate directly for cellular respiration in the presence of oxygen. They are the most abundant biomolecules on earth.
- Example: glucose, fructose, sucrose, maltose, starch, cellulose etc.

Classification of Carbohydrates

- Carbohydrates are divided into four major groups based on the degree of polymerization: monosaccharides, disaccharides, oligosaccharides, and polysaccharides.



Classification of Carbohydrates

1. Monosaccharides

- Monosaccharides are the simplest carbohydrates and cannot be hydrolyzed into other smaller carbohydrates. The “mono” in monosaccharides means one, which shows the presence of only one sugar unit.
- They are the building blocks of disaccharides and polysaccharides. For this reason, they are also known as simple sugars.
- The monosaccharides containing the aldehyde group are known as aldoses and the one containing ketone groups is called ketoses. Examples glucose, fructose etc.

2. Disaccharides

- Disaccharides consist of two sugar units. When subjected to a dehydration reaction, they release two monosaccharide units. The covalent bond formed between the two sugar molecules is known as a glycosidic bond.

Disaccharide	Monomer unit
Sucrose	Glucose, Fructose
Lactose	Galactose, Glucose
Maltose	Glucose, Glucose

Classification of Carbohydrates

3. Oligosaccharides

- Oligosaccharides are compounds that yield 3 to 10 molecules of the same or different monosaccharides on hydrolysis. All the monosaccharides are joined through glycosidic linkage. And based on the number of monosaccharides attached, the oligosaccharides are classified as trisaccharides, tetrasaccharides, pentasaccharides, and so on.
- Example: Fructooligosaccharides, Galactooligosaccharides, Mannooligosaccharides etc.

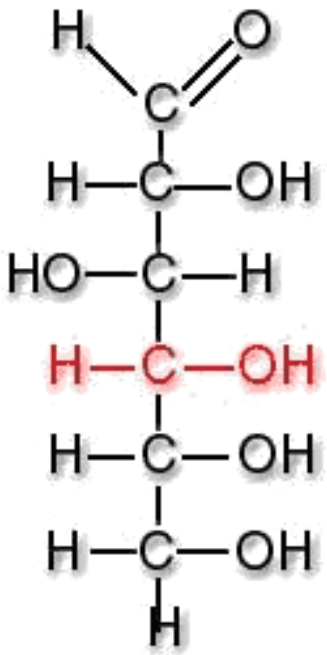
4. Polysaccharides

- Polysaccharides are a chain of more than 10 carbohydrates joined together through glycosidic bond formation. They are also known as glycans.
- Eg: Starch, Glycogen

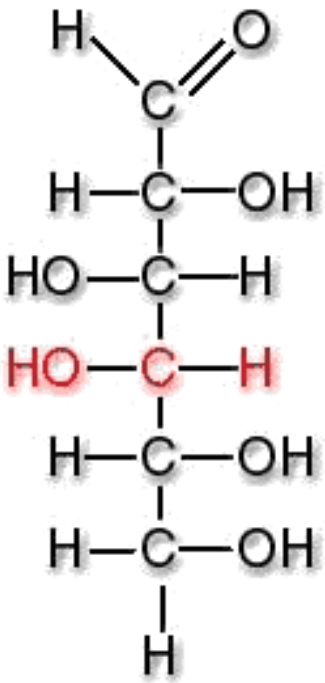
Chemical Nature of Carbohydrates

- When heated dry or with strong sulphuric acid, they undergo dehydration and charring with a characteristic burning sugar smell (caramelisation).
- They yield characteristic reactions of hydroxyl functional group like esterification, etherification, oxidation, dehydration, substitution with halogens, etc.
- Monosaccharide sugars also give reactions of aldehydes and ketones. They reduce Fehling's or Benedict s reagent, thus the alkaline cupric ion (blue colour) present in these reagents is precipitated as reddish-brown cuprous oxide.Some disaccharides also reduce these reagents. Sucrose does not reduce these reagents.
- Reducing sugars also react with Tollen's reagent (silver ammonia ion solution) forming a precipitate of fine silver mirror coloured on the glass all of the tube.
- Bromine water is decolourised by aldoses but not ketoses. Bromine water oxidises selectively the aldehyde group to carboxyl group, giving rise to the general class of compounds called aldonic acids.
- Concentrated nitric acid oxidises both the aldehyde and primary alcohol groups to the dicarboxylic acids known by the general name aldaric acids.

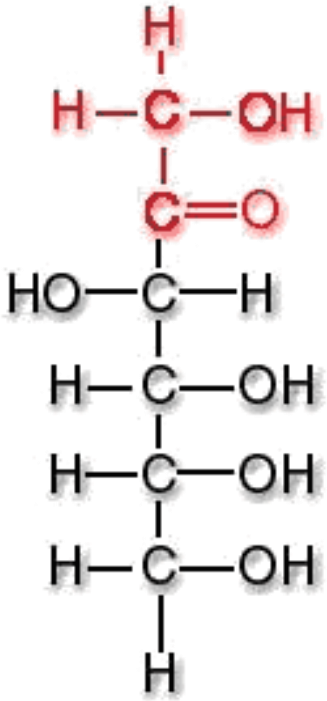
Structure of carbohydrates



Glucose



Galactose



Fructose

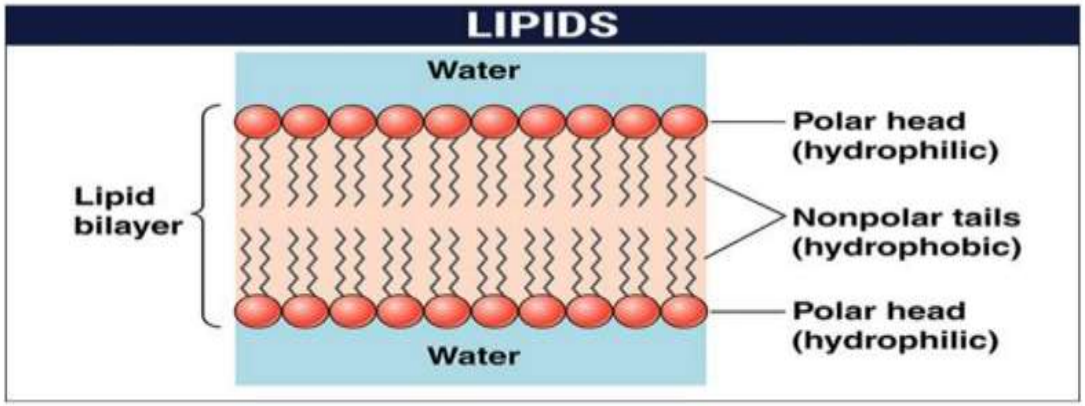
Biological role of carbohydrates

The biological significance of carbohydrates is discussed as follows:

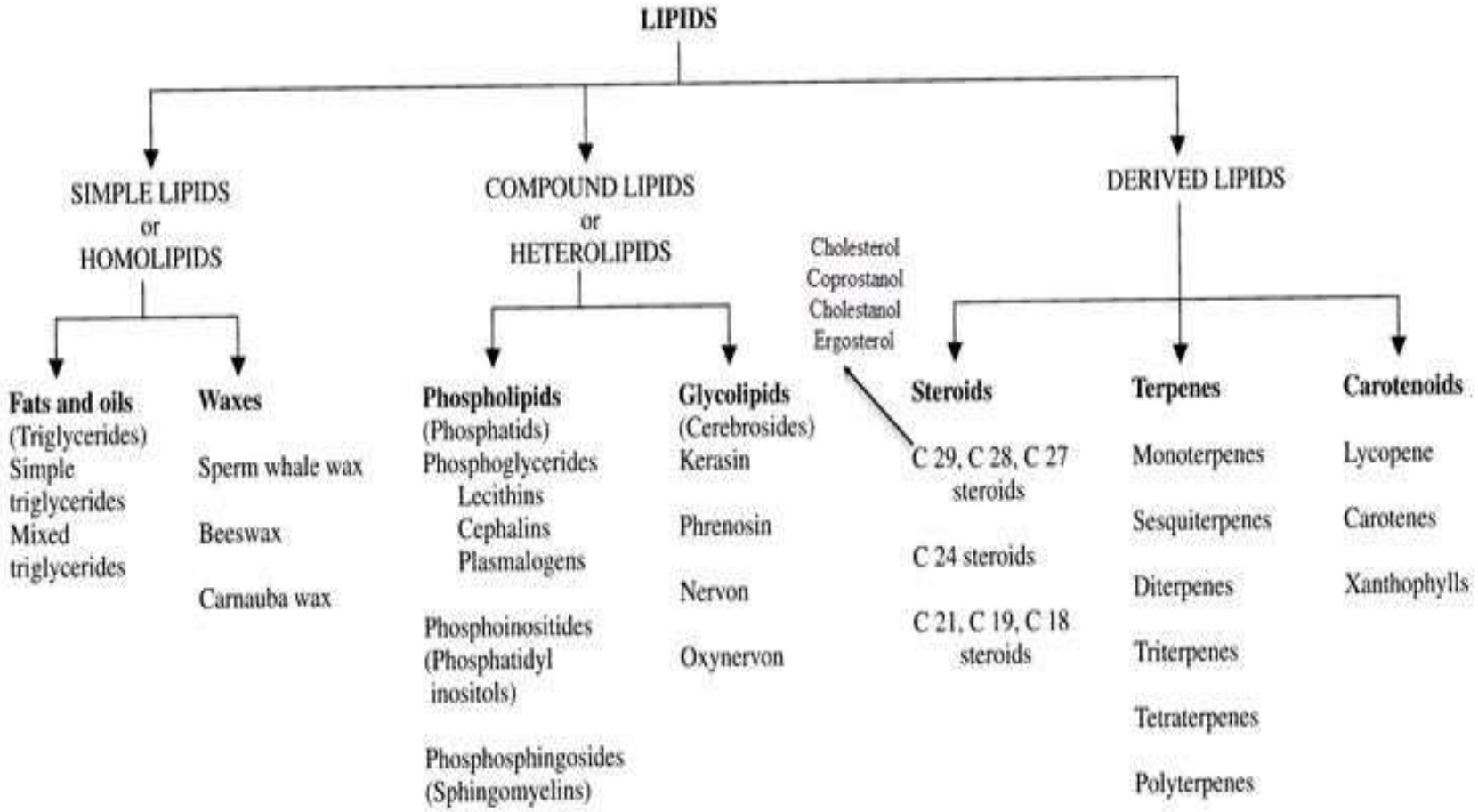
- They are immediate source of energy for living cell.
- They have protein sparing action.
- They are involved in breakdown of fatty acids and preventing ketosis.
- The glycocalyx present on cell surface. is composed of carbohydrates and proteins. The glycocalyx are involved in biological recognition processes of immunoglobulin and MHCs.
- They are major dietary fibre (cellulose) and are used as flavouring and sweetening agents..
- They also serve as stored forms of energy as glycogen in liver and muscles.
- They are important components of brain cells as neuramic acids, cerebrosides (glycolipids) and gangliosides.
- Pentose sugars (ribose and deoxyribose) form an important component of nucleic acids.
- Heparin, an example of the glycosaminoglycan family of carbohydrates, functions as physiological anticoagulant.
- Hyaluronic acid, a carbohydrate derivative, is an important component of the vitreous body of the eye. the umbilical cord and as a lubricant in synovial fluid of the joints.
- Inulin (homo-polysaccharide) is used for clinical purposes in clearance tests.
- Chondroitin sulphates A and C form the major structural components of cartilage, tendons and bones in association with collagen. Chondroitin sulphates are sulphated glycosaminoglycan composed of a chain of alternating sugars.

Lipids

- The word lipid is derived from the Greek work lipos meaning fat. Lipids are organic compounds containing carbon, hydrogen and oxygen. It is present in all plants and animal cells. They are naturally occuring waxy, greasy or oily organic compounds.
- They are source of high energy value therefore are important constituent of the diet. They are insoluble in water and soluble in organic solvents.
- The three main types of lipids are phospholipids, sterols, and triacylglycerols (also known as triglycerides).



Classification of Lipids



Classification of Lipids

1. Simple lipids:

- They are esters of fatty acids of various alcohols.
- **a. Fats:** Esters of fatty acids with glycerol. Oils are also fats but present in the liquid state.
- **b. Waxes:** Esters of fatty acids with higher molecular weight monohydric alcohols.

2. Complex lipids:

- Esters of fatty acids containing groups in addition to an alcohol and a fatty acid.

a. Phospholipids: Phospholipids are compound lipids, consisting of phosphoric acids, nitrogen base, alcohol and fatty acids. These compound lipids are major components of the cell membrane and also provide a fluid character to the membranes. In cell membranes, these phospholipids have a hydrophilic head and a hydrophobic tail, which forms the inside of the bilayer.

Types of Phospholipids There are two types of phospholipids

Glycerophospholipids

They are the major types of phospholipids, which occur in the biological membrane. It consists of glycerol-based phospholipids.

Sphingophospholipids

They are the important constituents of myelin and are abundantly found in the brain and nervous tissues. It consists of sphingosine as alcohol.

Classification of Lipids

Properties of Phospholipids

- They are signal mediators.
- They are amphipathic molecules.
- They anchor proteins within the cell membranes.
- They are the major constituents of cell membranes.
- They are the components of bile and lipoproteins.

Functions of Phospholipids

- It regulates the permeability of the membrane.
- It is also involved in the absorption of fat from the intestine.
- It helps in ETC- Electron Transport Chain in the mitochondria.
- Phospholipids help by preventing the accumulation of fats in the liver.
- It plays a major role in the transportation and removal of cholesterol from the cells.
- It forms the structural components of the cell membrane with the association of proteins.
- They act as surfactants in the respiratory system and are also involved in the coagulation of blood cells.
- It helps in the synthesis of different lipoproteins, prostacyclins, prostaglandins and thromboxanes.

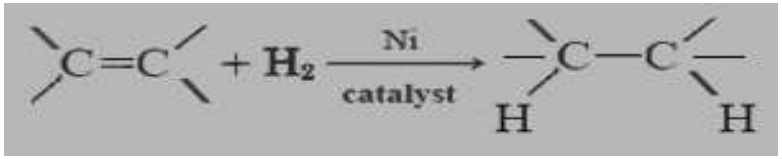
b. Glycolipids (glycosphingolipids): Lipids containing a fatty acid, sphingosine and carbohydrate.

3. Derived lipids:

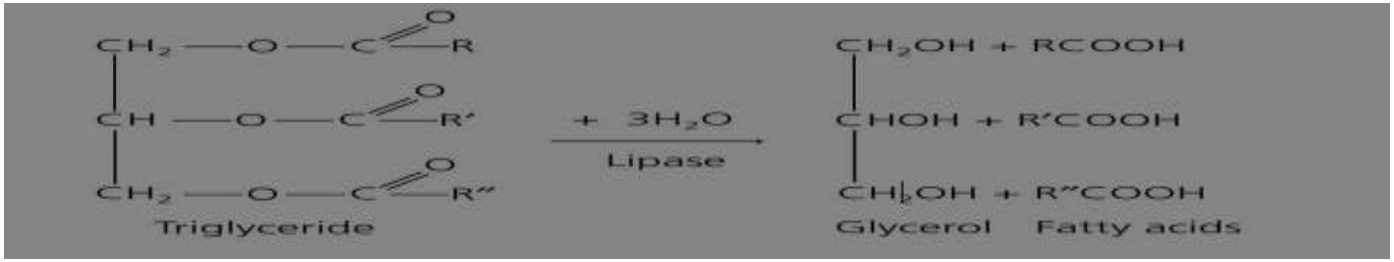
- These are hydrolysed derivatives of simple or compound lipids. Examples are fatty acids, glycerol, steroids, terpenes, carotenoids, fatty aldehydes, etc.

Chemical Nature of Lipids

- **Hydrogenation:** In this reaction, unsaturated fats react with hydrogen gas in presence of nickel catalyst and convert carbon-carbon double bonds to single bonds.

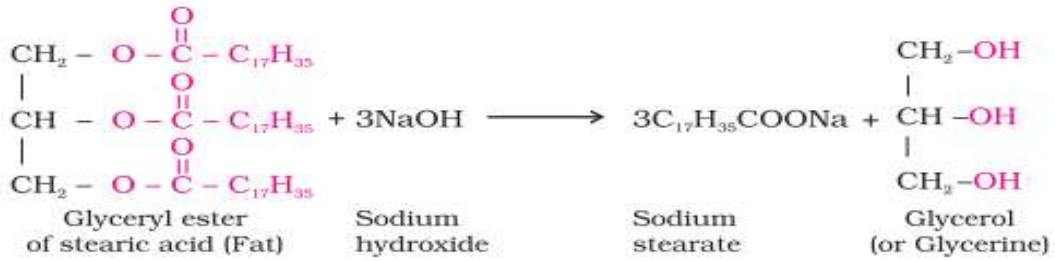


- **Hydrolysis:** Triacylglycerol are hydrolysed in the presence of strong acids or digestive enzymes. Thus, ester bonds are broken down, forming glycerol and three fatty acids.



- **Saponification:** In this reaction, fat or oil is heated with a strong base (e.g., NaOH). This reaction gives glycerol and the sodium salts of the fatty acids or soaps. KOH gives a softer liquid soap. Softer soaps can also be obtained by using polyunsaturated oils.

Chemical Nature of Lipids



- **Rancidity of fats:** The unpleasant odour and taste developed in the most natural fats natural fats on ageing is termed as rancidity. It may develop because the fats of the glycerides are hydrolysed into free fatty acids and glycerol. Lipases in the presence of moisture and at warm temperatures accelerate hydrolysis.
- **Acid Number:** It is defined as the milligrams of potassium hydroxide required for neutralisation of the free fatty acids present in one gram of given fat or oil. Rancidity due to free fatty acids can be determined by the acid number.
- **Reichert-Meissl Number:** It is also called volatile fatty acid number and is defined as the number of millilitres of 0.1N potassium hydroxide required to neutralise the soluble volatile fatty acids which is derived from 5 grams of saponified fat. The quantity of short chain fatty acids in the fat molecule can be determined by Reichert-Meissl number.
- **Iodine Number:** It is defined as the number of grams of iodine absorbed by 100 grams of fat. The relative unsaturation of fat is determined by measuring the quantity of halogen absorbed by the glycerides.

Biological role of lipids

1) Storage: They are storage compounds and in animal body they reserve energy in the form of triglycerides in adipocytes

2) Energy Source: As energy source they provide 9kcal of energy per gram. The per unit weight of fats supply two times more energy as compared to per unit weight of proteins or carbohydrates.

3) Cell Membranes: They are important components of cell membrane. Phosphoglycerides, sphingolipids, and steroids are structural components of cell membranes.

4) Membrane Permeability: They regulate membrane permeability.

5) Vitamins: They serve as source for fat soluble vitamins (A, D, E, and K). Therefore, lipids are essential for the effective absorption of fat soluble vitamins from the intestine.

6) Electrical Insulation: They act as electrical insulators to the nerve fibres, where the myelin sheath contains lipids.

7) Enzyme Systems: They are components of various enzyme systems.

8)Cellular Metabolic Regulators: Prostaglandins and steroid hormones act as cellular metabolic regulators.

9) Signalling: Being small and insoluble in water, they act as signalling molecules.

10) Thermal Insulation: Fat deposited in the subcutaneous layer provides insulation and protection from cold.

11) Fluidity and Flexibility: Polyunsaturated phospholipids are important constituents of phospholipids. They provide fluidity and flexibility to the cell membranes.

12) Transport: Lipoproteins transport cholesterol and triglycerides from their origin to sites of use or uptake (e.g., the liver, muscle, and fat tissue). Lipoproteins that are complexes of lipids and proteins occur in blood as plasma lipoprotein.

13) Essential Fatty Acids: Lipids also supply the essential fatty acids which are not synthesised in human body but are required for normal growth. Essential fatty acids like linoleic and linolenic acids are precursors of many different types of ecosanoids including prostaglandins and thromboxanes. These play important role in pain, fever, inflammation and blood clotting.

14) Cholesterol: They are found in cell membranes, blood, and bile of many organisms. They maintain the fluidity of membranes by interacting with lipid complexes. It is the precursor of bile acids, Vitamin D and steroids.

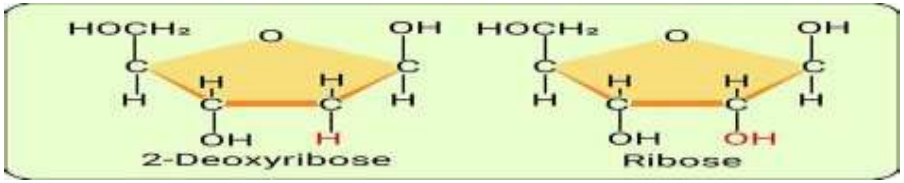
Nucleic Acids

- Nucleic acids are essential molecules in living cells that carry genetic information. They are classified into two main types: **deoxyribonucleic acid (DNA)** and **ribonucleic acid (RNA)**. Chemically, they are long-chain polymeric molecules made up of nucleotides, which consist of a five-carbon sugar, a nitrogenous base and a phosphate group. Biologically, nucleic acids play a crucial role in protein synthesis and the transfer of genetic information from one generation to the next.
- The monomeric unit of nucleic acids is known as nucleotide and is composed of a nitrogenous base, pentose sugar and phosphate group. The nucleotides are linked by a 3’ and 5’ phosphodiester bond.
- The nitrogen base attached to the pentose sugar makes the nucleotide distinct.
- There are 4 major nitrogenous bases found in DNA: adenine, guanine, cytosine, and thymine.
- In RNA, thymine is replaced by uracil.

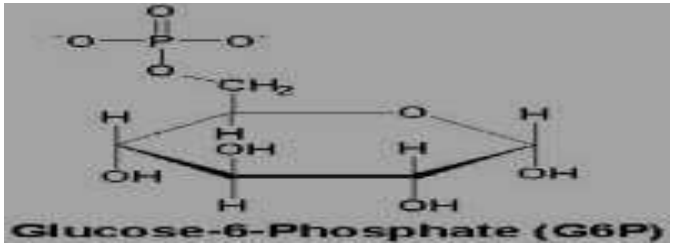
Chemical nature of Nucleic Acids

A nucleic acid consists of three parts, namely pentose sugar, phosphate group and heterocyclic nitrogenous bases:

1) Pentose Sugar: Two sugars, namely D-ribose and D-2-deoxyribose are commonly associated with nucleic acids.



2) Phosphate Group: The backbone of a nucleic acid is made up alternating sugar and phosphate molecules. The sugar and phosphate molecules are bonded together to form a long chain, as represented below

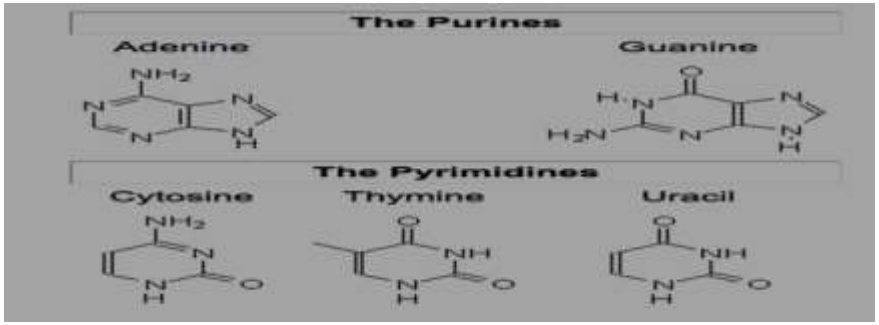


3) Heterocyclic Nitrogenous Bases/Nucleobases: These are nitrogenous heterocyclic compounds. **Cytosine (C), guanine (G), adenine (A) and thymine (T)** are present in DNA molecule, whereas thymine is replaced by **uracil (U)** in RNA molecule. Nuceleobases are complementary in nature and are present in the form of pair as **cytosine-guanine, adenine-thymine** (in DNA) and **uracil-thymine** (in RNA). The two nuceleobases are linked toegether by hydrogen bonds. These nucleobases can be grouped into two classes, namely:

Chemical nature of Nucleic Acids

i)Purines: These are double-ringed nitrogenous compounds. **Adenine and guanine** are the two major purine bases, however some other purines (e.g., 1,2- and 3-methyladenine; 6-methylaminopurine; 3-methylguanine; etc.) have also been isolated

i) Pyrimidines: These are single-ringed nitrogenous compounds. **Uracil, thymine and cytosine** are the major pyrimidine bases, however some pyrimidine bases (e.g.,5-methylcytosine and 5-hydroxymethylcytosine) have also been isolated.

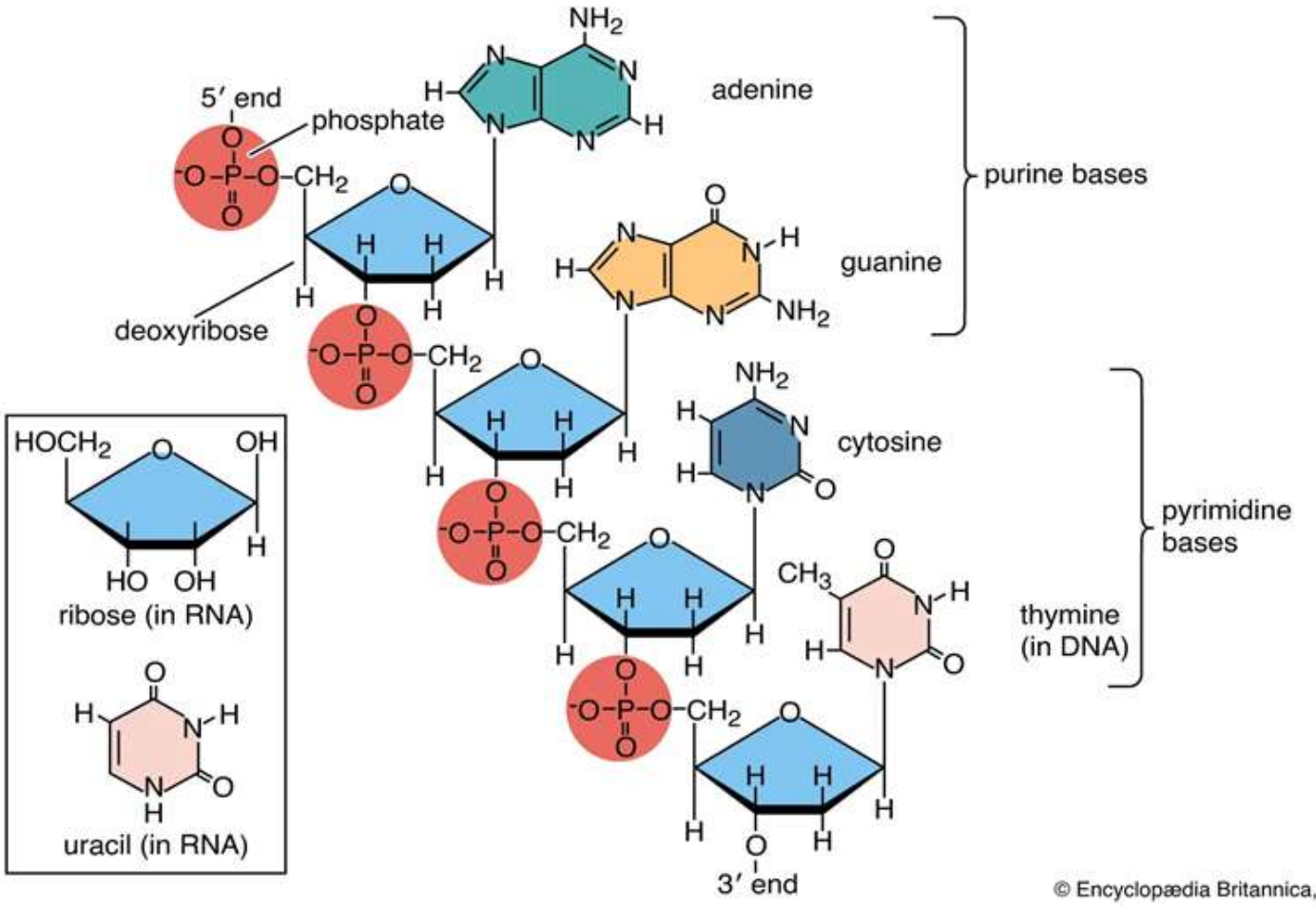


In the polynucleotide chain, the phosphate sugars form the phosphate ester chain through C-3 and C-5 hydroxyl groups and the nucleobases are attached to them at C-1 position via ß-glycosidic linkage.

Nucleoside: A purine or pyrimidine base combines with a ribose or deoxyribose sugar to form a nucleoside. Nitrogenous bases conjugate with pentose sugar (ribose or deoxyribose) by a ß-glycosidic linkage Thus, ribonucleosides are formed by conjugation of nuceleobases with ribose sugar; and deoxyribonucleosides are formed by conjugation of nucleobases with deoxyribose sugar.

Nucleotide: A nucleoside combines with phosphoric acid to form a nucleotide (base + sugar + phosphate = nucleotide) e.g., adenylic, guanylic, cytidylic, inosinic and uridylic acids. Thus, nucleotide is a phosphate of nucleoside.

Structural pattern of nucleic acids



Biological role of nucleic acids

Biological Role of DNA

- In living beings it serves as a genetic material and is responsible for the characteristic features of living organism (e.g., colour of the skin and eye, height, intelligence, etc.).
- It carries information regarding cellular protein synthesis. The segment of DNA carrying protein information is known as gene
- A parent transfers their DNA to the offspring. So the information moves from one generation to another of a species. Thus, DNA inherits information from parent cells to the daughter cells.

Biological Role of RNA

- The mRNA is a direct carrier of genetic information from the nucleus to the cytoplasm.
- The tRNA is a carrier of amino acids to the site of protein synthesis
- The rRNA is required for the formation of ribosomes

Amino Acids

Amino acids are the basic building blocks of proteins that serve as the nitrogenous backbones for compounds like neurotransmitters and hormones in human body. The word amino acid itself comprises of two words amino + acid. This means, chemical structure of amino acids contains two important parts: Amine group (-NH_2 group) and Carboxylic acid group (COOH group)

Any organic molecule with atleast one carboxyl group and atleast one amino group is called an amino acid.

Naturally there are 300 amino acids, out of them only 20 aminoacids form protein molecules.

Classification of amino acids

Amino acids can be classified:

1) On the basis of carbon chain present

2) On the basis of nutritional requirement

3) On the basis of polarity.

1) On the basis of carbon chain present

On the Basis of Carbon Chain Present, amino acids are of three types:

a)Aliphatic Amino Acids: These are further classified into:

i) Neutral (Monoamino-Monocarboxylic Acids): Eg: alanine, serine, threonine, valine, leucine, and isoleucine.

ii) Acidic (Monoamino-Dicarboxylic Acids): For example, aspartic acid, asparagine, glutamic acid and glutamine.

iii) Basic: For example, arginine, lysine and hydroxylysine.

iv) Sulphur Containing Amino Acids: For example, cysteine, cystine and methionine.

b) Aromatic Amino Acids: For example, phenylalanine, tyrosine, and thyroxine

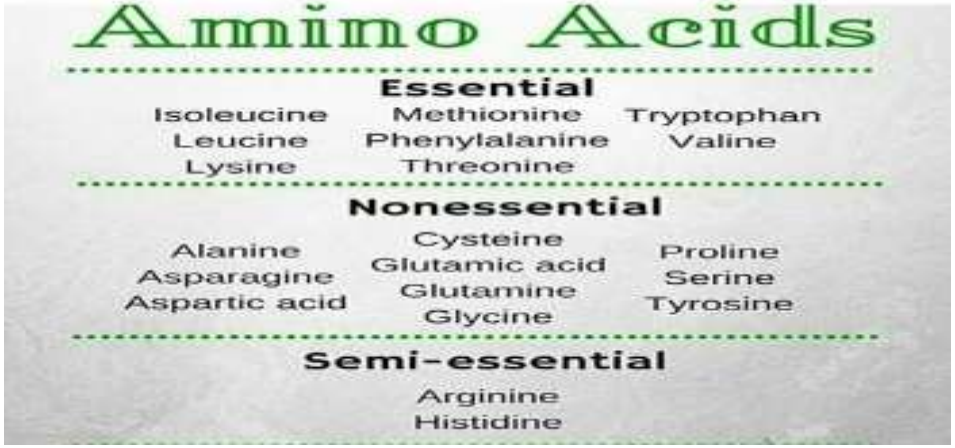
c) Heterocyclic Amino Acids: For example, proline, hydroxyproline, tryptophan and histidine.

Classification of amino acids

2) On the basis of nutritional requirement

a) Essential Amino Acids: These amino acids are also termed as indispensable amino acids. They are not synthesised in the body and are obtained from dietary sources.

b) Non-Essential Amino Acids: These amino acids are termed as dispensable amino acids, and are synthesised in the body.



3) On the Basis of polarity

On the basis of their polarity, amino acids are of four types:

a) Non-polar Amino Acids: These amino acids (eg, alanine, valine, leucine, isoleucine, phenylalanine, glycine, tryptophan, methionine, and proline) are neutral molecules having equal number of amino and carboxyl groups. The nature of these amino acids is hydrophobic and the R side chain does not have any charge.

Classification of amino acids

b) Polar Amino Acids with no charge: These amino acids do not bear any charge on the side chain ‘R’(eg: serine, threonine, tyrosine, cysteine, glutamine, aspargine). They are involved in hydrogen bonding of protein structure.

c) Polar Amino Acids with Positive Charge: These amino acids, (eg. lysine, arginine, and histidine) carry more number of amino groups, thus are basic in nature. The 'R' side chain of these amino acids bears a positive charge.

d) Polar Amino Acids with Negative Charge: These amino acids are (eg: aspartic acid and glutamic acid) acidic in nature because they carry more number of carboxyl groups. The 'R' group of these amino acids bears negative charge. These amino acids are also termed as dicarboxylic mono amino acids.

Chemical Nature of Amino acids

1)Reaction due to Carboxyl Groups:

Salt formation with NaOH: Amino acid with alpha carbon gives salt with NaOH. Eg: Glycine reacts with NaOH to form sodium glycinate.

$$C_2H_5NO_2 + NaOH \rightarrow C_2H_4NO_2Na + H_2O$$

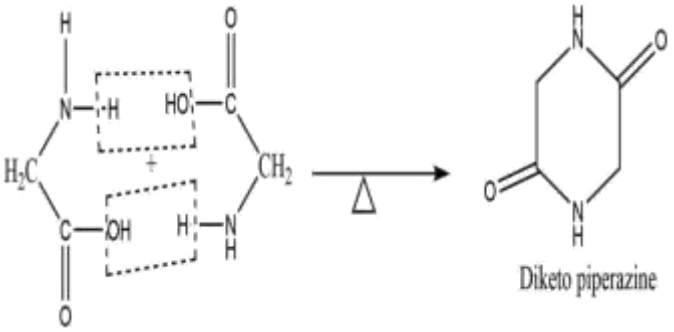
2) Reaction due to Amino Group:

Salt Formation with Mineral Acids: The amino group reacts with mineral acids and produce its salt.

$$NH_2\text{-}CH_2COOH + HCl \rightarrow Cl^-H_3N^+\text{-}CH_2COOH$$

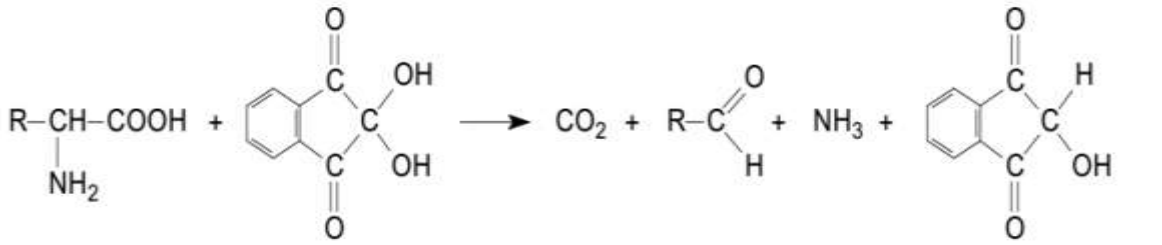
3)Reaction due to Both – NH and - COOH Group:

Effect of Heat: On heating at high temperature (around 200°C), the alpha amino acids (eg. Glycine) dehydrate and yields diketopiperazine.



Chemical Nature of Amino acids

4) Ninhydrin Reaction: An oxidative reaction takes place between amino acid and ninhydrin which results to purple-violet coloured pigment. This is specific test for identification and estimation of amino acids.



Ninydrin Reduced ninydrin

5) Reaction with formaldehyde:Formaldehyde combines to the amino end of alpha amino acid and forms N,N-dihydroxymethyl derivative.

Biological role of amino acids

Amino acids have several important biological roles:

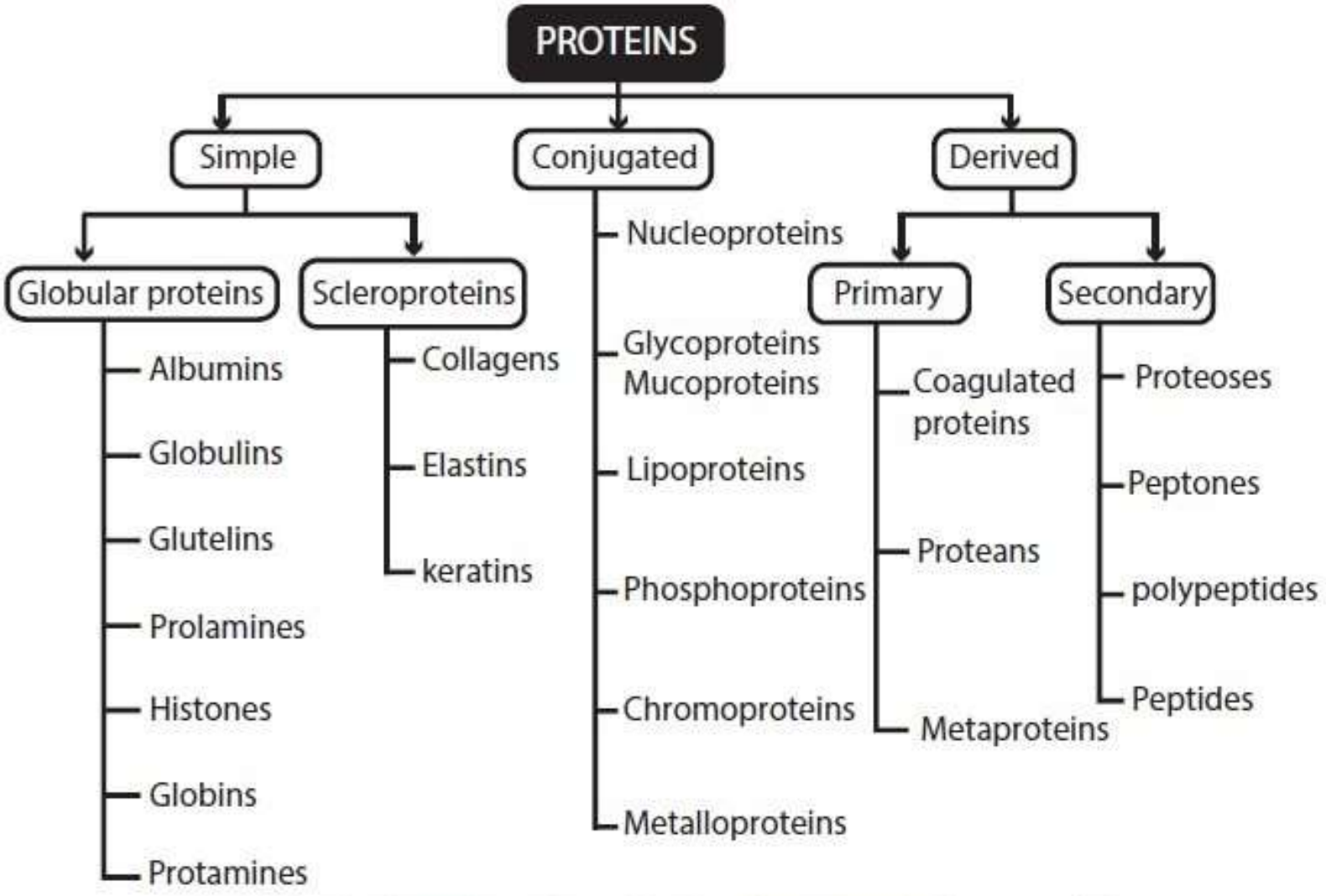
- They are the building blocks of polypeptides and proteins.
- They play a role in metabolic pathways.
- They are involved in gene expression.
- They regulate cell signal transduction.
- Proteins formed from amino acids are essential for virtually all cell functions, including enzyme activity, antibody production, and structural support.
- Amino acids are also involved in tissue building and repair, food digestion, and molecule transportation.

Proteins

Proteins are high molecular organic compounds. The long polymer chain of protein is derived from amino acid monomer. The amino acid monomers are joined together by the peptide bonds between the carboxyl and amino groups. Protein molecule chemically consists of nitrogen, carbon, hydrogen, oxygen, sulphur and phosphorus.

Protein molecules form colloidal solution and difference in solubility between the two classes is related to a difference in molecular shape.

Classification of proteins



Classification of proteins

1)Simple proteins: These proteins only consist of amino acid and are further classified into:

i) Globular Proteins: These proteins are spherical or oval-shaped, soluble in water or in other solvents and digestible. For example,

Proteins	Properties	Examples
Albumins	Soluble in water forming dilute salt solutions, but coagulates on heating.	Serum albumin, ovalbumin (egg), lactalbumin (milk)
Globulins	Soluble in neutral and dilute salt solutions.	Serum globulins, vitelline (egg yolk)
Glutelins	Soluble in dilute acids and alkalis and mostly found in plants.	Glutelin (wheat), oryzenin (rice)
Prolamines	Soluble in 70% alcohol	Gliadin (wheat), zein (maize)
Histones	Strongly basic proteins, soluble in water and dilute acids but insoluble in dilute ammonium hydroxide.	Thymus histones, histones of codfish sperm
Globins	Resemble histones, but are not basic in nature and not precipitated by NH_4OH.	Thymus histones, histones of codfish sperm
Protamines	Strongly basic and resemble histones but smaller in size and soluble in NH_4OH.	Sperm proteins

Classification of proteins

ii) Fibrous protein: These proteins (fibre-like in shape) are water insoluble and cannot be digested. Albuminoids or scleroproteins constitute the major group of fibrous proteins. For example,

Examples	Properties
Collagens	Connective tissue proteins but do not have tryptophan. On boiling with water or dilute acids, yield gelatine which is soluble and digestible.
Elastin	Protein of elastic tissues such as tendons and arteries.
Keratins	Present in exoskeletal structures like hair, nails, horns.

2) Conjugated proteins: These proteins are made up of amino acids and non-protein moiety (prosthetic or conjugating group). For example,

Proteins	Properties	Examples
Nucleoproteins	Prosthetic group is a nucleic acid either DNA or RNA.	Nucleohistones, nucleoprotamines
Glycoproteins	Prosthetic group is carbohydrate.	Mucin (saliva), ovomucoid (egg white)
Lipoproteins	Prosthetic group is lipid.	Serum lipoproteins

Classification of proteins

3) Derived Proteins: These proteins are derived from simple and conjugated proteins. They are two types.

i) Primary Derived Proteins: These proteins are denatured or coagulated or first hydrolysed products of proteins.

Proteins	Properties	Examples
Coagulated proteins	Denatured proteins produced by heat, acid, alkalis etc	Cooked proteins, coagulated albumin (egg white)
Proteans	First stage products of protein hydrolysis by enzymes, dilute acids, alkalis, etc., which are insoluble in water.	Myosan, Edestan

ii) Secondary Derived Proteins: These proteins are the degraded (due to breakdown of peptide bonds) products of proteins.

Proteoses: They are hydrolytic products of proteins which are soluble in water and coagulated by heat.

Peptides: They are composed of very small number of amino acids joined by peptide bonds.

Chemical nature of proteins

Denaturation and Renaturation

- Proteins can be denatured by agents such as heat and urea that cause unfolding of polypeptide chains without causing hydrolysis of peptide bonds.
- The denaturing agents destroy secondary and tertiary structures, without affecting the primary structure.
- If a denatured protein returns to its native state after the denaturing agent is removed, the process is called renaturation.
- Some of the denaturing agents include:
- Physical agents: Heat, radiation, pH
- Chemical agents: Urea solution which forms new hydrogen bonds in the protein, organic solvents such as benzene, CCl_4, phenol, toluene, detergents.

Biological role of proteins

- Vital for the growth and repair.
- Have enormous diversity of biological function and are the most important final products of the information pathways.
- Proteins, which are composed of amino acids, serve in many roles in the body (e.g., as enzymes, structural components, hormones, and antibodies).
- Act as structural components such as keratin of hair and nail, collagen of bone etc.
- Shows homostatic control of the volume of the circulating blood and that of the interstitial fluids through the plasma proteins.
- They perform hereditary transmission by nucleoproteins of the cell nucleus.
- Ovalbumine, glutelin etc. are storage proteins.
- Actin, myosin act as contractile protein important for muscle contraction.
- Proteins are the molecular instruments through which genetic information is
- expressed.
- Execute their activities in the transport of oxygen and carbon dioxide by hemoglobin and special enzymes in the red cells.
- Involved in blood clotting through thrombin, fibrinogen and other protein factors.
- Acts as the defense against infections by means of protein antibodies.

Biological role of proteins

Type of protein	Examples	Functions
Digestive	Amylase, lipase, pepsin, trypsin	Help in digestion of food by catabolizing nutrients into monomeric units
Transport	Hemoglobin, albumin	Carry substances in the blood or lymph throughout the body
Structural	Actin, tubulin, keratin	Construct different structures, like the cytoskeleton
Hormones	Insulin, thyroxine	Coordinate the activity of different body systems
Defense	Immunoglobulins	Protect the body from foreign pathogens
Contractile	Actin, myosin	Effect muscle contraction
Storage	Legume storage proteins, egg white (albumin)	Provide nourishment in early development of the embryo and the seedling

Important previous year questions

- 10 marks
  - Define and classify nucleic acids. (5m part- Aug 2023)
- 5 marks
  - Define and classify carbohydrates(Sep 2018, Oct 2022)
  - Describe the relationship between free energy, enthalpy and entropy.(Mar 2019)
  - Discuss in detail about redox potential. (Sep 2019, Oct 2022, Mar 2023)
  - What are phospholipids? Describe classification and functions of any two phospholipids. (Sep 2019)
  - Explain bioenergetics and concept of free energy (Mar 2020)
  - Classify proteins with suitable examples (Jan 2022)
  - ATP (Jan 2022)
  - Functions of cyclic AMP (May 2022)
  - Phospholipids (Oct 2022)
  - Define lipids. Classify lipids with examples (Mar 2023, Dec 2023)
  - Define amino acids. Classify amino acids with examples (Mar 2023, May 2022)

Important previous year questions

- 2 marks
  - Write any two functions of nucleic acids (Sep 2018)
  - Define enthalpy and entropy. (Mar 2019, Mar 2023, Dec 2023)
  - Define biomolecules (Sep 2019)
  - Exergonic reaction (Sep 2019, Aug 2023)
  - Endergonic reaction (Mar 2020, Aug 2023)
  - Significance of ATP (Mar 2020)
  - Essential fatty acids with examples (Mar 2020, Oct 2022, Mar 2023
  - Name sulphur containing amino acids (Jan 2022)
  - cAMP (Jan 2022)
  - Essential aminoacids (May 2022)
  - Define carbohydrates with examples (Oct 2022)
  - Define protein (Mar 2023)
  - Significance of ATP and cyclic AMP (Aug 2023)
  - Identification test for protein (Aug 2023)
  - Redox potential (Aug 2023)
  - Concept of free energy (Dec 2023)