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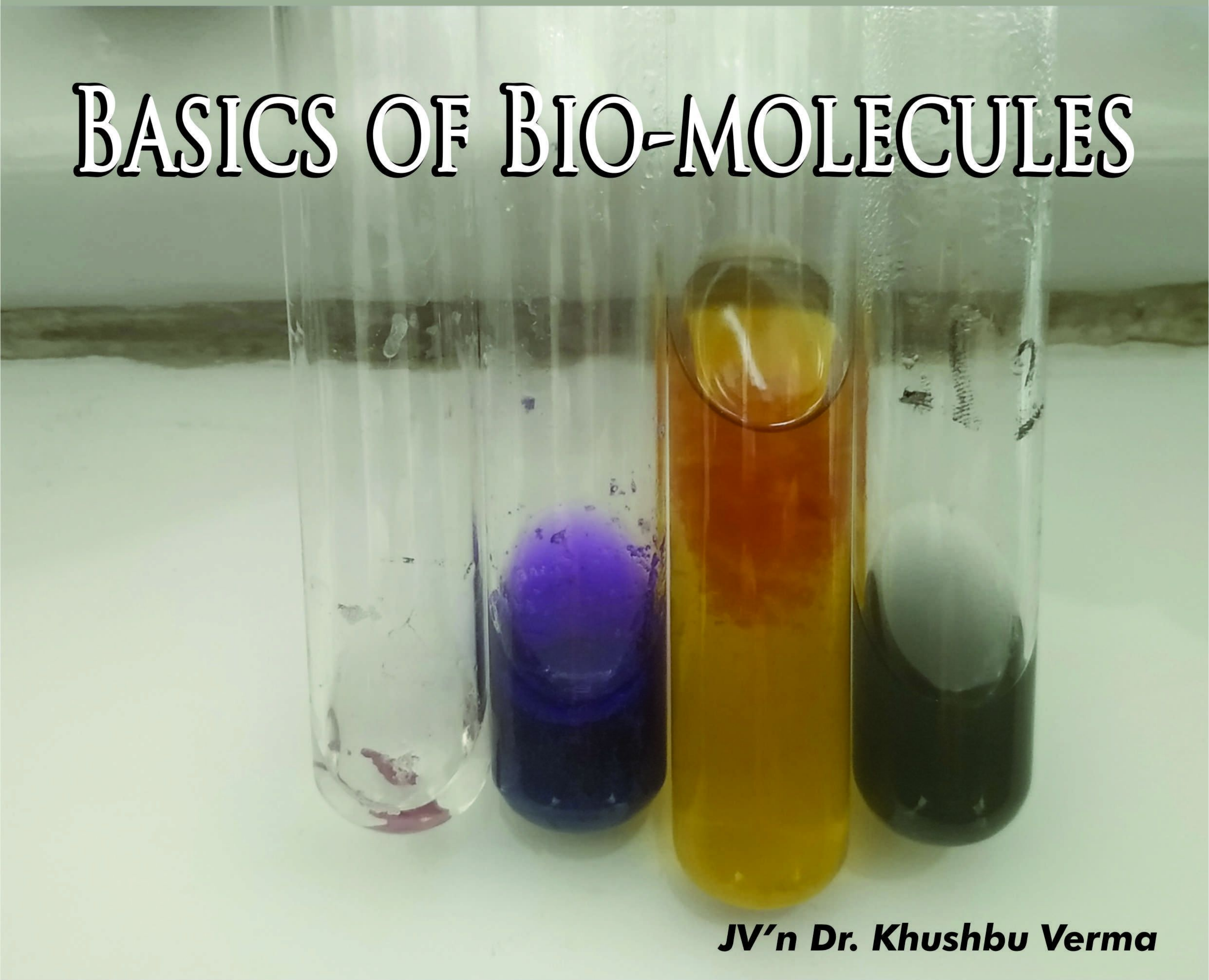
BASICS OF BIO-MOLECULES



JV'n Dr. Khushbu Verma

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Index

Chapter -1

Molecules Of Life

All life on Earth is made up of four distinct types of molecules. These four types of molecules are often called life molecules.

The four life molecules are proteins, carbohydrates, lipids, and nucleic acids. Each of these four groups is essential to all life on Earth. Without any of these four elements, the cell and the body would not survive. All four living molecules are essential for the structure or function of cells and, in most cases, are essential for both.

Proteins

Proteins are essential for life molecules and are actually the building blocks of health. Proteins are the most common particles found in cells. When all the water is removed from the cell, the protein makes up more than half the remaining weight.

Protein molecules are involved in various aspects of cell biology. They come in a variety of forms and perform many functions. They are involved in muscle mass, energy storage, digestion, immune defenses, and much more.

The basic structure of a protein is a long chain made of many small molecules called amino acids. There are 20 amino acids used to make proteins. Different amino acids can be grouped into billions of successive compounds that make up a different protein. A long chain of amino acids wrap itself and wrap itself to produce the final structure of protein.

Amino acids contain nitrogen. Nitrogen-based chemicals are an important part of the diet of everything so that they can produce new proteins in their cells. This is why farmers often apply nitrogen fertilizers that help their crops grow and why it is important for people to eat foods that contain protein.

Carbohydrates

The subsequently four life molecules are carbohydrates. Carbohydrates are an significant foundation of energy. They also supply cellular support and facilitate communication between cells.

The carbohydrate molecule is made up of atoms in carbon, hydrogen and oxygen. They are found in the form of sugar or a lot of sugar mixed together.

A solo sugar molecule is known as monosaccharide. Two sugar molecules are bound together by a disaccharide and many sugar molecules form a polysaccharide. Three different types of carbohydrates are all important for a variety of reasons.

Carbohydrates are an important foundation of energy for many living things. Plants use solar energy to convert CO_2 into carbohydrates. The energy of these carbohydrates later allows plants to grow and reproduce.

Many living things are known as the cell wall around their cell. The cell walls of plants and fungi are made up of carbohydrates. Cell walls provide vital protection against plant and fungal cells.

Lipids

Lipids are a flexible group of molecules that include fats, oils, waxes, and other steroids. These molecules are mainly made up of carbon and hydrogen chains called fatty acids. Fatty acids combine with one set of other atoms to form many different lipids.

Cells need lipids for many reasons. Perhaps the most important role of lipids is in the primary cell. A type of lipid called phospholipid is the main molecule found in cell components.

Other significant functions of lipids include heat heating, energy storage, protection and cellular communication. The importance of these various functions is why lipids are counted as one of the four life molecules.

Approximately all lipids do not dissolve in water. The formation of lipid cells means that they are resistant to water. This is why oils and fats form globules in water and why vinegar and vinaigrette oil separate when the mixture is left for a while.

Nucleic Acids

The final of the four molecules of life are the nucleic acids. There are two types of nucleic acids that are essential to all life. These are DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).

DNA is a very well-known type of molecule that makes up the genetic material of a cell. DNA is responsible for carrying all the information an organism needs to survive, grow and reproduce.

RNA is a lesser-known molecule but it also plays an important role in cells. RNA molecules are used to translate the information stored in DNA molecules and use the information to help build proteins. Without RNA, the information in DNA would be useless.

Chapter – 2
Carbohydrate

• Carbohydrates are a group of obviously occurring carbonyl compounds (aldehydes or ketones) that also enclose several hydroxyl groups.

• They can also comprise their derivatives which construct such compounds by hydrolysis.

• These are the mainly plentiful organic molecules in nature and also referred to as "saccharides"

• Water soluble and sweet carbohydrates are called "sugars".

Structure of Carbohydrates

- Carbohydrates are made of carbon, hydrogen and oxygen.
- The universal experimental structure of carbohydrates is (CH2O) n.
- They are organic compounds organized in the appearance of aldehydes or ketones with multiple hydroxyl groups released from the carbon chain.
- The building blocks all carbohydrates are simple sugars called monosaccharides.
- The monosaccharide can be mono-hydroxy aldehyde (aldose) or polyhydroxy ketone (ketosis).
- Carbohydrates can be represented structurally in any of three forms:
- Open chain structure.
- Hemi- Acetal structure
- Haworth structure.

Open chain structure – It is the long straight-chain shape of carbohydrates.

Hemi-acetal structure – at this point the 1st carbon of the glucose condenses with the -OH group of the 5th carbon to figure a ring structure.

Haworth structure – It is the company of the pyranose ring structure.

Characteristics of Carbohydrates

Physical Characteristics of Carbohydrates

• **Stereoisomerism -** Compounds that shave the same structural method but differ in spatial configuration. Example: glucose has two isomers with respect to the penultimate carbon atom. They are D-glucose and L-glucose.

• **Optical activity -** It is the rotation of glucose (+) and glucose (-) that form polarized light in the plane.

• **Diastereal Isomers -** Changes the configuration with respect to C2, C3 or C4 in glucose. Example: mannose, galactose

• **Annomerism -** It is the spatial configuration with respect to the first carbon atom in aldoses and to the second carbon atom in ketoses.

Chemical Characteristics of Carbohydrates

- **Osazone formation**: Osazone are carbohydrate derivatives when sugars are reacted with an excess of phenylhydrazine. eg. Glucosazone
- **Benedict's test:** Reducing sugars while heated in the company of an alkali gets converted to powerful reducing species identified as enediols. When Benedict's reagent solution and reducing sugars are heated jointly, the solution mutates its color to orange-red/ brick red.
- **Oxidation:** Monosaccharides are reducing sugars if their carbonyl groups oxidize to give carboxylic acids. In Benedict's test, D-glucose is oxidized to D-gluconic acid thus, glucose is measured a reducing sugar.
- **Reduction to alcohols:** The C=O groups in open-chain forms of carbohydrates can be reduced to alcohols by sodium borohydride, $NaBH_4$, or catalytic hydrogenation (H2, Ni, EtOH/H2O). The products are known as "alditols".

Properties of Monosaccharides

- Mainly monosaccharides have a sweet taste (fructose is sweetest; 73% sweeter than sucrose).
- They are solids at room temperature.
- They are tremendously soluble in water: – in spite of their high molecular weights, the attendance of large numbers of OH groups create the monosaccharides a great deal more water-soluble than most molecules of similar MW.
- Glucose can soluble in minute amounts of water to make a syrup (1 g / 1 ml H2O).

Classification of Carbohydrates (Types of Carbohydrates)

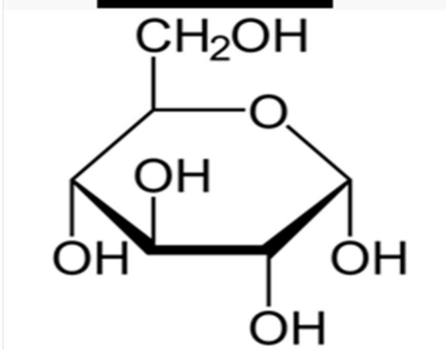
The simple carbohydrates comprise single sugars (monosaccharides) and polymers, oligosaccharides, and polysaccharides.

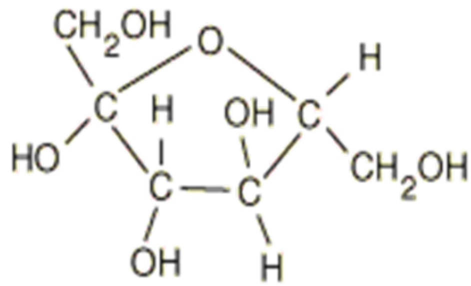
Monosaccharides

- Simplest assemblage of carbohydrates and regularly called simple sugars since they cannot be further hydrolyzed.
- Colorless, crystalline solid which are soluble in water and insoluble in a non-polar solvent.
- These are compound which possesses a free aldehyde or ketone group.
- The general formula is $C_n(H2O)_n$or $C_nH_{2n}O_n$.

- They are classified according to the number of carbon atoms they surround and also on the basis of the functional group present.
- The monosaccharides thus with 3,4,5,6,7… carbons are called trioses, tetroses, pentoses, hexoses, heptoses, etc., and also as aldoses or ketoses depending upon whether they contain aldehyde or ketone group.
- Examples: **Glucose, Fructose, Erythrulose, Ribulose.**

D- Glucose

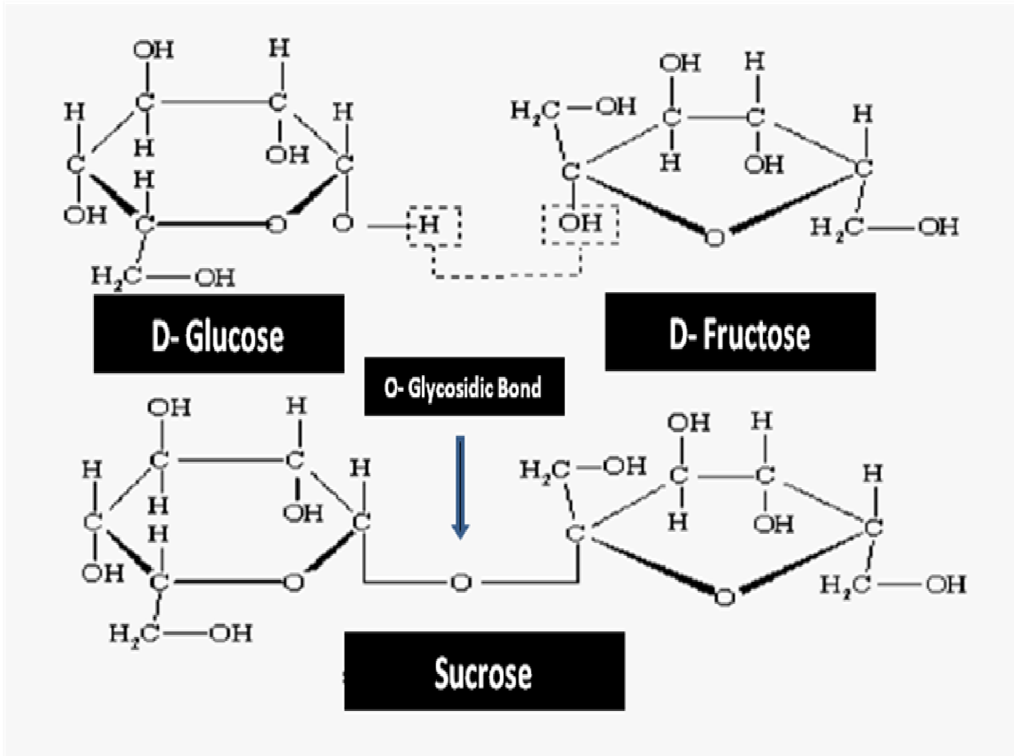


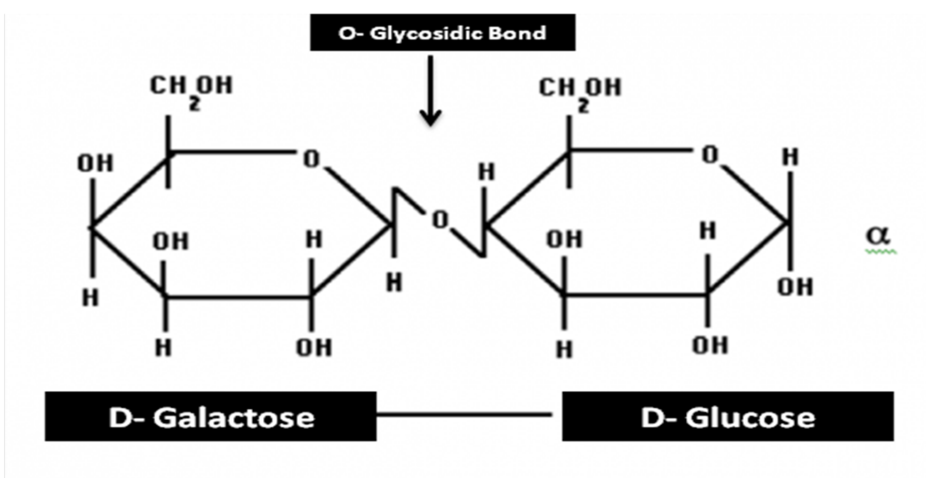


D- Fructose

Oligosaccharides

- Oligosaccharides are complex sugars that yield 2 to 10 molecules of the similar or diverse monosaccharides on hydrolysis.
- The monosaccharide units are connected by glycosidic connection.
- Based on the numeral of monosaccharide units, it is supplementary classified as disaccharide, trisaccharide, tetrasaccharide etc.
- Oligosaccharides yielding 2 molecules of monosaccharides on hydrolysis is identified as a disaccharide, and the ones yielding 3 or 4 monosaccharides are recognized as trisaccharides and tetrasaccharides respectively and so on.
- The universal formula of disaccharides is $C_n(H2O)_{n-1}$and that of trisaccharides is $C_n(H2O)_{n-2}$ and so on.
- Examples: **Disaccharides include sucrose, lactose, maltose, etc.**
- Trisaccharides are Raffinose, Rabinose.

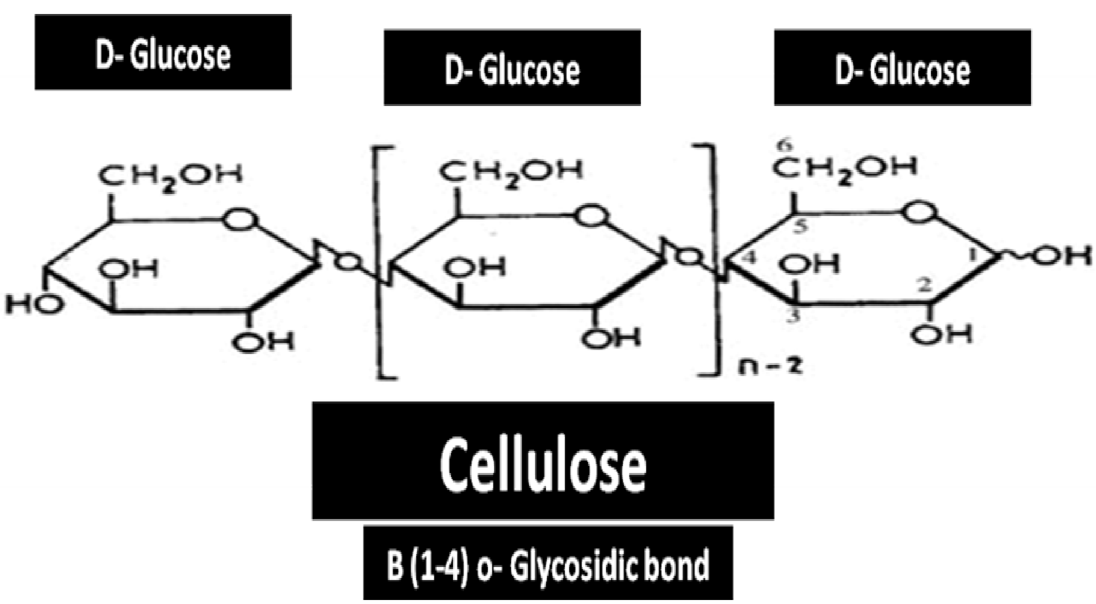

D- Glucose
D- Fructose
O- Glycosidic Bond
Sucrose


O- Glycosidic Bond
α
D- Galactose
D- Glucose

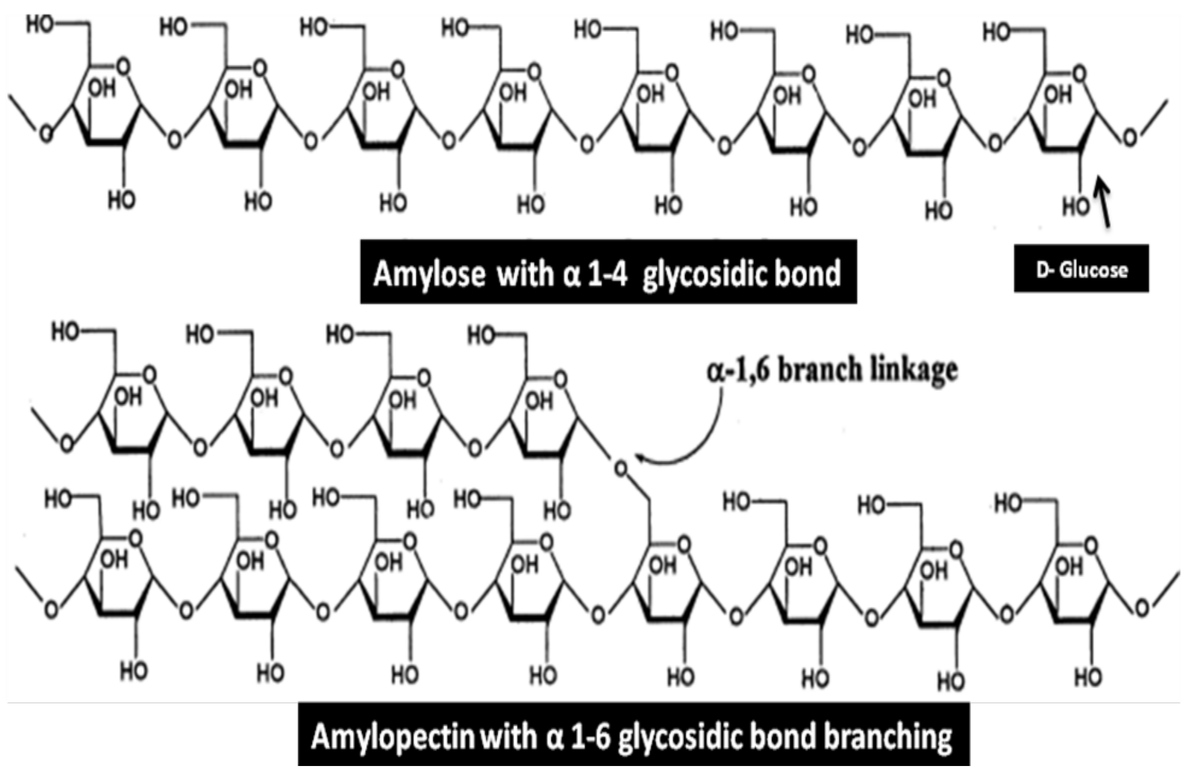
Lactose

Polysaccharides

- They are also called as “glycans”.
- Polysaccharides hold more than 10 monosaccharide units and can be hundreds of sugar units in extent.
- They yield more than 10 molecules of monosaccharides on hydrolysis.
- Polysaccharides fluctuate from each other in the identity of their recurring monosaccharide units, in the length of their chains, in the types of bond linking units and in the degree of branching.
- They are chiefly concerned with two important functions ie. Structural functions and the storage of energy.
- They are additional classified depending on the kind of molecules formed as a result of hydrolysis.
- They may be **homopolysaccharidese**, containing monosaccharides of the same type or **heteropolysaccharides** i.e., monosaccharides of different types.
- Examples of Homopolysaccharides are **starch, glycogen, cellulose, pectin.**
- Heteropolysaccharides are Hyaluronic acid, Chondroitin.



Structure of Cellulose



Sturcture of Starch

Functions

Carbohydrates are extensively dispersed molecules in plant and animal tissues. In plants and arthropods, carbohydrates from the skeletal structures, they also dish up as food reserves in plants and animals. They are significant energy foundation required for a variety of metabolic activities, the energy is imitative by oxidation.

several of their major functions comprise:

- Living organisms employ carbohydrates as accessible energy to fuel cellular reactions. They are the most plentiful dietary source of energy (4kcal/gram) for all living beings.
- Carbohydrates along with being the chief energy source, in many animals, are instant sources of energy. Glucose is broken down by glycolysis/ Kreb's cycle to yield ATP.
- They serve as repositories of energy, fuel and metabolic intermediaries. It is stored as glycogen in animals and starch in plants.
- Stored carbohydrates act as an energy source instead of protein.

• They form structural and protective components, as in the cell wall of plants and microorganisms. Structural elements in the cell walls of bacteria (peptidoglycan or murein), plants (cellulose) and animals (chitin).

• Carbohydrates are intermediaries in the biosynthesis of fats and proteins.

• Carbohydrates help in the regulation of nervous tissue and are the source of energy for the brain.

• Carbohydrates associate with lipids and proteins to form surface antigens, receptor molecules, vitamins, and antibiotics.

• Formation of the structural framework of RNA and DNA (ribonucleic acid and deoxyribonucleic acid).

• They are linked to many proteins and lipids. These bound carbohydrates are important in cell-cell communication and in interactions between cells and other elements of the cellular environment.

• In animals, they are an important component of connective tissues.

• High fiber carbohydrates help prevent constipation.

• In addition, they help in the modulation of the immune system.

Chapter-3

Protein

Protein Structure

- The linear sequence of amino acid residues in a polypeptide chain determines the three-dimensional configuration of a protein and the structure of a protein determines its function.
- All proteins contain the elements carbon, hydrogen, oxygen, nitrogen and sulfur some of which may also contain phosphorus, iodine and traces of metals such as ion, copper, zinc and manganese
- A protein can contain 20 different types of amino acids. Each amino acid has an amino group on one end and an acid group on the other and a separate side chain
- The backbone is the same for all amino acids while the side chain differs from one amino acid to another.

The structure of proteins can be divided into four levels of organization:

1. **Primary Structure**

   • The primary structure of a protein consists of the amino acid sequence along the polypeptide chain. The amino acids are bound by peptide bonds.

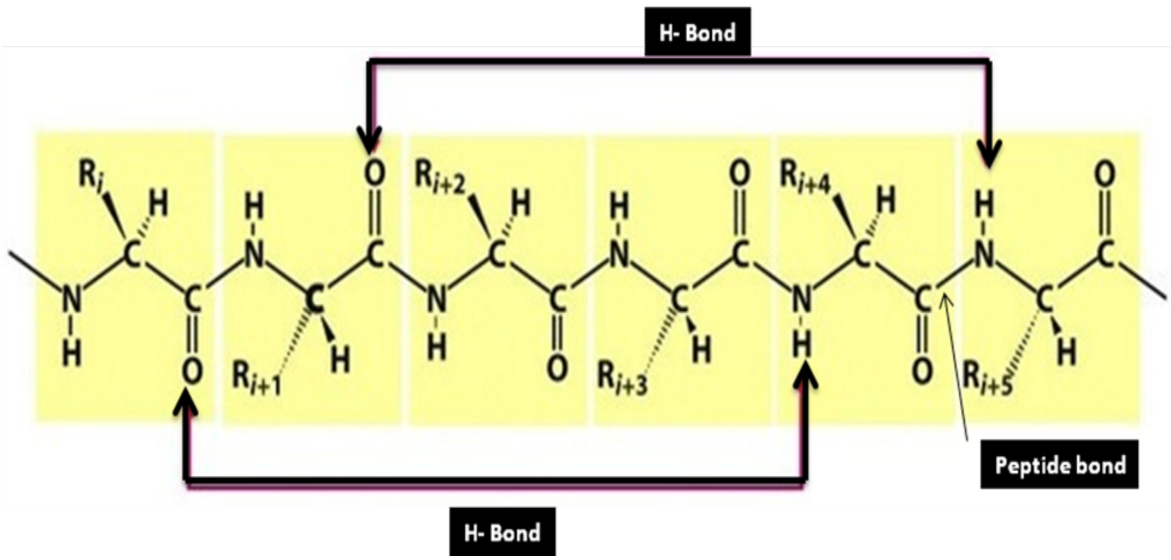
   • Since there are no dissociable protons in the peptide bonds, the charges on the polypeptide chain are due only to the N-terminal amino group, the C-terminal carboxyl group, and the side chains on the amino acid residues

   • The basic structure determines the additional levels of regulation of protein molecules.

2. Secondary Structure

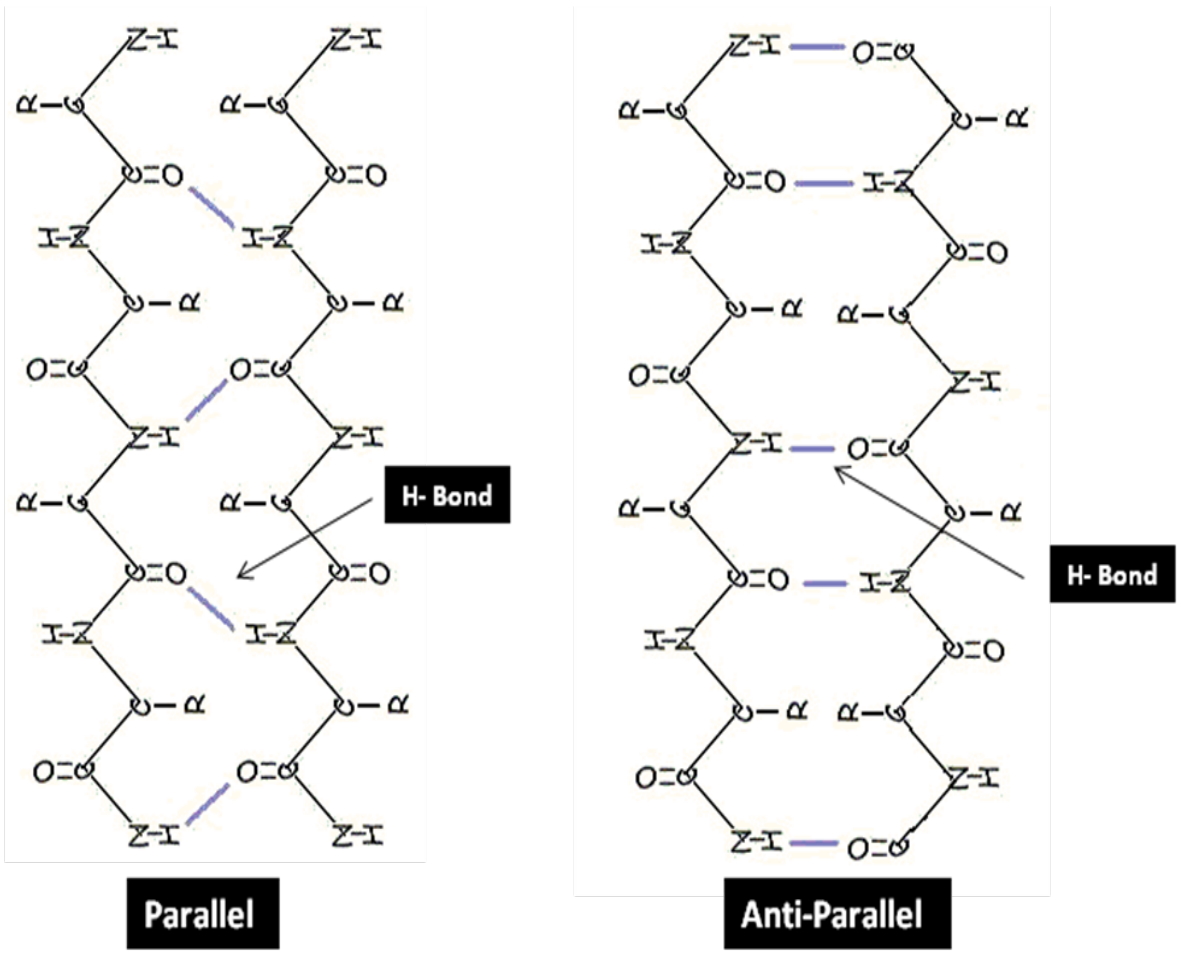
- The secondary structure includes various types of local conformations in which the atoms of the side chains are not involved.
- Secondary structures are formed by a regular repeating pattern of hydrogen bond formation between backbone atoms.
- The secondary structure involves α-helices, β-sheets, and other types of folding patterns that occur due to a regular repeating pattern of hydrogen bond formation.
- The secondary structure of protein could be :

1. **Alpha-helix**



2. **Beta-helix**

- The α-helix is a right-handed coiled strand.
- The side-chain substituents of the amino acid groups in an α-helix expand to the exterior.
- Hydrogen bonds shape between the oxygen of the C=O of each peptide bond in the strand and the hydrogen of the N-H group of the peptide bond four amino acids under it in the helix.
- The side-chain substituents of the amino acids fit in beside the N-H groups.
- The hydrogen bonding in a ß-sheet is between strands (inter-strand) rather than within strands (intra-strand).
- The sheet conformation consists of pairs of strands lying side-by-side.
- The carbonyl oxygens in one strand hydrogen bond with the amino hydrogens of the neighbouring strand.
- The two strands can be either parallel or anti-parallel depending on whether the strand directions (N-terminus to C-terminus) are the similar or conflicting.
- The anti-parallel ß-sheet is additional steady due to the extra well-aligned hydrogen bonds.



β Pleated Sheet

3. Tertiary Structure

- Tertiary structure of a protein refers to its generally three-dimensional conformation.
- The types of interactions among amino acid residues that produce the three-dimensional shape of a protein comprise hydrophobic interactions, electrostatic interactions, and hydrogen bonds, all of which are non-covalent.
- Covalent disulfide bonds also happen.
- It is produced by interactions between amino acid residues that may be located at a considerable distance from each other in the primary sequence of the polypeptide chain.
- Hydrophobic amino acid residues tend to collect in the interior of globular proteins, where they exclude water, whereas hydrophilic residues are usually found on the surface, where they interact with water.

4. Quaternary Structure

- Quaternary structure refers to the interaction of one or more subunits to form a functional protein, using the same forces that stabilize the tertiary structure.
- It is the spatial preparation of subunits in a protein that consists of more than one polypeptide chain.

Types-

Based on the chemical nature, structure, shape and solubility, proteins are classified as:

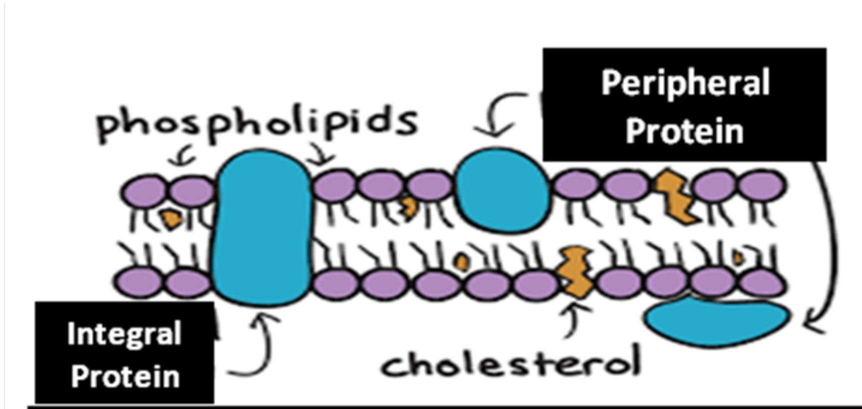
1. **Simple proteins**: They are composed of simply amino acid residue. On hydrolysis these proteins give way simply ingredient amino acids. It is additional divided into:
   - Fibrous protein: Keratin, Elastin, Collagen
   - Globular protein: Albumin, Globulin, Glutelin, Histones
2. **Conjugated proteins**: They are joint with non-protein moiety. Eg. Nucleoprotein, Phosphoprotein, Lipoprotein, Metalloprotein etc.
3. **Derived proteins**: They are imitative or besmirched products of easy and conjugated proteins. They might be :
   - Primary derived protein: Proteans, Metaproteins, Coagulated proteins
   - Secondary derived proteins: Proteosesn or albunoses, peptones, peptides.

Functions of Proteins

Proteins are imperative for the development and repair, and their functions are everlasting. They also have huge diversity of biological function and are the mainly significant last products of the information pathways.

- Proteins are composed of amino acids, dish up in numerous roles in the body (e.g., as enzymes, structural components, hormones, and antibodies).
- They perform as structural components such as keratin of hair and nail, collagen of bone etc.
- Proteins are the molecular instruments during which genetic information is expressed.
- They carry out their activities in the transport of oxygen and carbon dioxide by hemoglobin and special enzymes in the red cells.
- They purpose in the homostatic control of the quantity of the circulating blood and that of the interstitial fluids throughout the plasma proteins.
- They are involved in blood clotting through thrombin, fibrinogen and other protein factors.
- They perform as the resistance against infections by resources of protein antibodies.

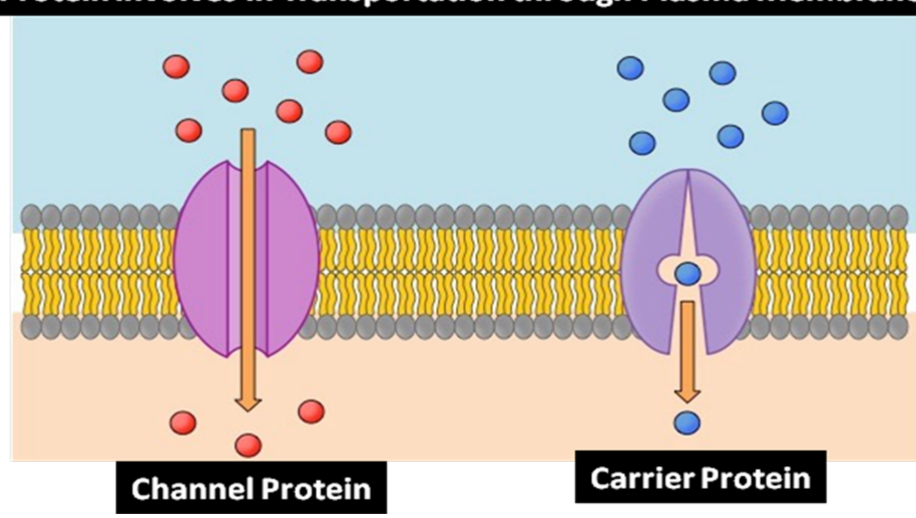
- They achieve hereditary communication by nucleoproteins of the cell nucleus.
- Ovalbumine, glutelin etc. are storage proteins.
- Actin, myosin act as contractile protein significant for muscle contraction.



2 types protein involve in plasma structure

- **Facilitated diffusion**, like simple diffusion but is mediated by Transport proteins.
- **Carrier proteins** undergo a subtle change in shape that translocates the solute-binding site across the membrane. (Glucose transporter GLUT)
- **Channel proteins** provide corridors that allow a specific molecule or ion to cross the membrane
- Channel proteins include
  - **Aquaporins**, for facilitated diffusion of water
  - **Ion channels** that open or close in response to a stimulus (**gated channels- Ligand Gated and Voltage Gated**)

Protein Involves in Transportation through Plasma Membrane



Chapter-4

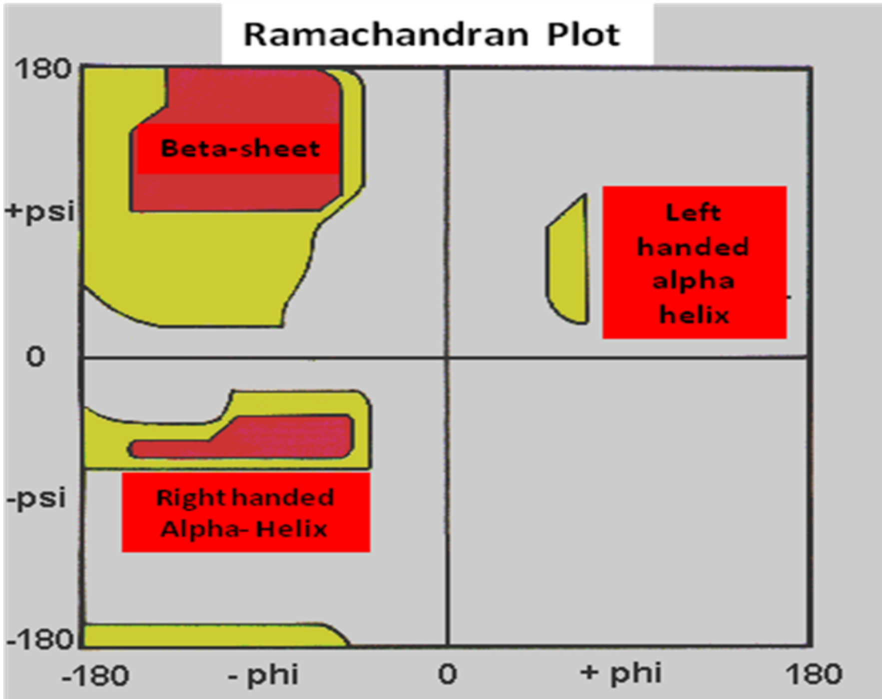
The Ramachandran Plot

In a polypeptide, the N-Calpha and Calpha-C main chain bonds are comparatively free to revolve. These rotations are symbolize by the twist angles phi and psi correspondingly.

G N Ramachandran used computer models of diminutive polypeptides to analytically differ phi and psi with the aim of finding steady conformations. For every conformation, the structure was examined for close contacts between the atoms. The atoms were treated as hard spheres with dimensions corresponding to their van der Waals radii. consequently, the phi and psi angles that reason the spheres to collide communicate to sterically disallowed conformations of the polypeptide backbone.

In the diagram beyond the white areas communicate to the conformations in which the atoms in the polypeptide approach the sum of their van der Waals radii. These regions are sterically banned for all amino acids excluding glycine which is unique in that it lacks a side chain. The red regions communicate to conformations where there are no steric clashes, that is, they are the permitted regions and that is the alpha-helical and beta-sheet conformations. The yellow areas demonstrate the allowed regions if a somewhat shorter van der Waals radius is used in the computation, i.e. the atoms can get a little closer. This brings out an additional region that corresponds to the left-handed alpha-helix. L amino acids cannot figure extended regions of the left helix but infrequently single residues recognize this conformation. These residues are typically glycine but can also be asparagine or aspartate anywhere the side chain forms a hydrogen bond with the chief chain and thus soothe this otherwise unfavorable conformation. Helix 3 (10) is located close to the upper right of the alpha-helical region and is on the edge of the permissible region representative lower stability.

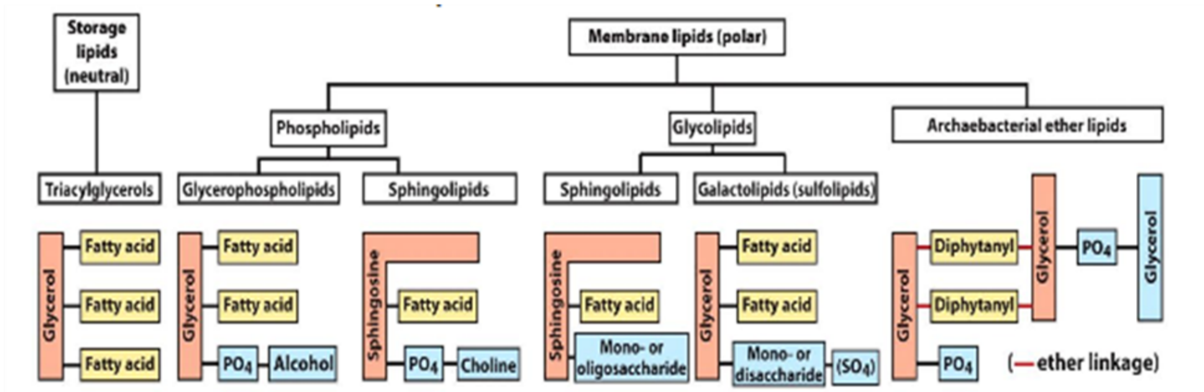
Disqualified regions generally result in a steric hindrance between the C-beta methylene group of the side chain and the main chain atoms. Glycine has no side chain and consequently can adopt phi and psi angles in all four quadrants of the Ramachandran diagram. So frequently protein regions in turn occur anywhere any other residue would be sterically caught up.



Example of Ramachandran Plot

Chapter-5

Lipid



Classification of Lipid

Classification of lipid on the basis of composition:

Simple (Homolipid)	**Complex (Heterolipid)**	**Derived lipid**
i) Neutral fat Eg. triglyceride	i) Phospholipid	i) Sterol and steroids
ii) Wax E.g. Bee's wax, Carnauba's wax	ii) Glycolipid	ii) Terpenes
	ii) Sulpholipid	iii) Carotenoids
	iv) Aminolipid	iv) Lycopenes
	v) Proteolipids	v) Carotin
	vi) Lipolipids	vi) Xanthophyll

A. Simple lipids:

They are further divided into neutral fat and oil and wax.

i. Fat and oil:

- ✓ Fats and oils are triglycerides, triacylglycerol (TAG) in which 3 acids are linked to a single glycerol molecule by an ester bond.
- ✓ A TAG that contains the same type of fatty acid is called a simple TAG, and those that contain different types of fatty acids are called mixed TAGs.
- ✓ Many oils and oils are naturally occurring in blends.
- ✓ The most common fatty acids are C16, C18, a type of palmitic acid, steric acid and oleic acid. Triglyceride absorbs 98% of dietary lipid. It is a source of energy and usually builds a fat depot. Fat contains a lot of saturated acids and therefore is water at room temperature.
- ✓ Oils and oils are not naturally polar and hydrophobic because the OH group of glycerol and COOH fatty acid group is involved in building ester bonds and is not found in H-bonding.

- **Functions:**

  - ✓ Fats and oils give energy to the cell. Oxidation rate of mixture of one gram of oil extraction of 9.3kcal.
  - ✓ They are significant source of energy when carbohydrates are not found in the cell.
  - ✓ They have a protective effect in the cold. They are stored in the seed as an oil depot and help during seed germination.
  - ✓ In the sperm whale, the presence of triglyceride gives energy (lifting).
  - ✓ They are the last energy sources built mainly by the lower layer.

ii. Wax:

- ✓ R_1-OH (monohydroxy alcohol) + HO-OCR_2 (fatty acids)à R_1-O-C=OR_2 (wax) + H_2O
- ✓ CH_3-$(CH_2)_{28}$-CH_2OH (myricyl alcohol) + CH_3-$(CH_2)_{14}$-COOH (palmitic acid) à CH_3-$(CH_2)_{28}$-CH_2-O-C=O-$(CH_2)_{14}$-CH_3 (myricyl palmitate) (Bee’s wax).
- ✓ Waxes are a fatty acid ester with a high concentration of monohydroxy alcohol.
- ✓ Different types of alcohol and FA are found in a variety of natural waxes. Examples: bee wax, myricyl alcohol, palmitic acid, carnauba wax, tetracosanol, tetra triacosanol.
- ✓ Wax is stronger and more hydrophobic than oil and oil due to its high hydrocarbon distribution.
- ✓ Waxes are hidden in the sebaceous glands, preen gland (under the feathers of a bird), bees, wool, whale semen etc.

- **Functions:**

  They act as a source of energy for other seagulls. Eg. planks. Because of their water-repellent properties and smooth texture. They are used to prepare cosmetic products and boot polish.

B. Complex lipids:

- They are additional divided into:
  - Phospholipids
  - Glycolipids

1. Phospholipid:

- They are additional divided into two types:
  - Glycerophospholipid
  - Spingophospholipid

i. ***Glycerophospholipid:***

- ✓ Glycerophospholipid contains glycerol where two fatty acids are linked to OH group glycerol by ester bond and a third -OH group of glycerol is linked to a phosphate group linked to the main acting group.
- ✓ Substitute group groups differ from different glycerophospholipids.

Name of glycerophospholipids	**Name and formula of -X**
Phosphatidic acid	Hydrogen
Phosphatidylcholine (lecithin)	Choline (CH_2-CH_2-N+$(CH_3)_3$
Phosphatidyl ethanol amine	Ethanol amine (-CH_2CH_2-NH_2)
Phosphatidyl serine	Serine ($HOCH_2$-$CHNH_2$-COOH)
Phosphatidyl inositol -4,5-bisphosphate	Myoinositol-4,5-bisphosphate

ii. Spingophospholipids: (Spingomylein):

- ✓ Spingophospholipid enclose an amino alcohol called spingosine instead of glycerol.

- ✓ In spingophospholipid, one fatty acid is connected with $-NH_2$ group of spingosine by peptide bond and -OH group of spingosine linked with PO_3^{-} with in twist connected with head group substituents.
- ✓ Spingophospholipid (ceramide):
- ✓ Head group are dissimilar in spingolipid.
- ✓ If the head group in choline after that it is known as spingomylein.

Utility of Phospholipids:

- Phospholipids are structural machinery of cell membrane. They create lipid bilayer of cell membrane.
- Lecithin assists in transport and metabolism of further lipids in animal.
- Lecithin deficiencies origin deposition of great quantity of fat in liver causing fatty liver.
- Phosphatidyl inositol-4,5-bisphosphate assist in directive of cell organization and metabolism.
- Platelets aggregating factor assist in aggregation of platelets and liberate of serotonin from platelets.
- Assist in enzyme catalysis, ETS cycle.
- Phosphatidyl ethanol amine (cephalin) play significant role in cell division, cell fusion etc.
- Phosphatidyl serine is a flippase enzyme.

2. Glycolipids:

- They are of two types:
  - Glyceroglycolipids
  - Spingoglycolipids

i. Glyceroglycolipids:

- ✓ In glyceroglycolipid, two fatty acids are connected with glycerol by ester bond and their OH group of glycerol is linked with carbohydrate head group.

ii. Spingoglycolipids:

- ✓ It consists of spingosine instead of glycerol in which $-NH_2$ group is linked with fatty acids by peptide bond and -OH group is linked with carbohydrate head group.

- ✓ Head group is diverse in different spingoglycolipid.

Functions of glycolipids:

- They are structural constituent of cell membrane.
- O, A, B antigen on RBC surface conclude blood group.
- Assist in signal transduction.
- Role in growth and tissue differentiation as well as carcinogenic.
- Gangliosides are present in brain (6%).

Sulpholipids:

- ✓ They are sulfate ester of glycolipid.
- ✓ Establish in chloroplast, chromophore of bacteria.

Aminolipids:

- ✓ Typically found in bacteria in external and inner membrane, it is also known as mololipid. E.g. lipid encloses serine.
- ✓ $-(CH_2)_6-CH_2-CHOH-CH_2-C=O-NH-CHCH_2OH-COOH$
- ✓ Found in Serectia.
- ✓ Lipid having glycine: iso-3-hydroxyheptadecanoic acid linked to glycine.
- ✓ Proteolipid: enclose protein attached to lipid.

C. Derived lipids:

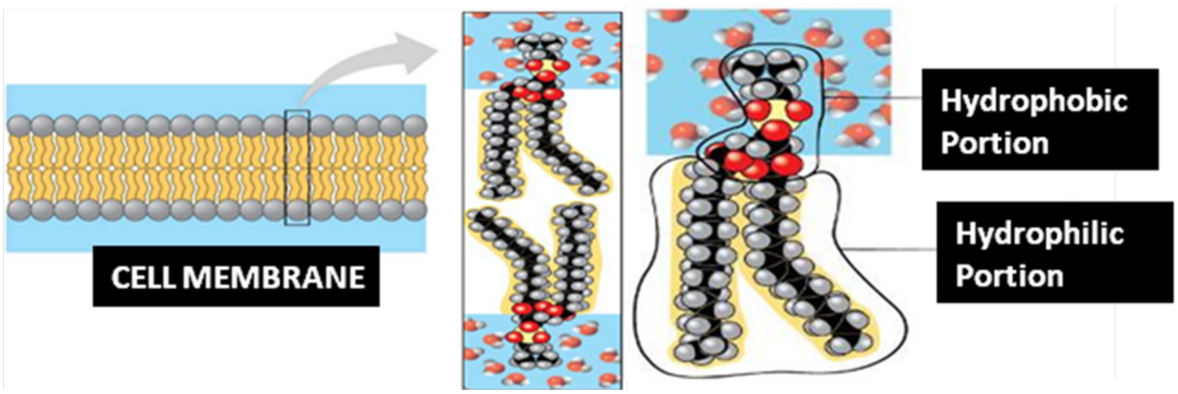
- ✓ They are the hydrolyzed product of easy and composed lipids with a variety of type of other compounds such as alcohol, ketone, vitamin D, sex-hormone steroid, terpenes, carotenoids.

Steroid:

- ✓ Sterane ring (Cyclopentanoperhydrophenanthrene).
- ✓ Sterane is parent compound.
- ✓ All steroids are derivatives of sterane. They are extra hydrophobic than other lipids.
- ✓ E.g. cholesterol, sex hormone, Vit.D.

Significance of Work

Lipds are having structural importance in Lipid billaye part of plasma membrane



Chemical constituents of plasma membrane

- The basic structure of plasma membrane is the phospjolipid bilayer
- Bilayer is composed of 2 leaflets of amphiphatic phospholipids molecules-

(a) Polar head

(b) Non polar tails

- Hydrophobic interactions are the main force to organize lipid bilayer

Chapter-6

Vitamins

Vitamins are a group of chemically diverse organic compounds that an organism requires for normal metabolism. Apart from a few exceptions (e.g., vitamin D), the human body cannot synthesize vitamins on its own in sufficient amounts and must, therefore, ensure a steady supply through the diet. Vitamins are micronutrients that do not provide energy (like macronutrients) but instead have very specific biochemical roles. They can be coenzymes in various reactions (B vitamins, vitamins A and K) and/or antioxidants that protect the cell and its membrane from free radicals (vitamins C and E). They can also enable cell signaling (vitamin A) and gene transcription (vitamins A and E) or function as hormones (e.g., vitamin D). Vitamins are classified into fat-soluble vitamins, which the body can store, and water-soluble vitamins, which, with the exception of vitamins B9 (folate) and B12 (cobalamin), the body cannot store over significant periods of time and, therefore, require continuous intake. A balanced diet typically supplies the body with all vitamins it requires. Deficiencies occur mainly due to malnutrition, malabsorption disorders, or restrictive diets (e.g., vitamin B12 deficiency in a vegan diet).

	Fat-soluble vitamin	**Water-soluble vitamin**
Vitamins	• Vitamin A (retinol) • Vitamin D (calciferol) • Vitamin E (tocopherol) • Vitamin K (phytomenadione)	• Vitamin B_1 (thiamine) • Vitamin B_2 (riboflavin) • Vitamin B_3 (niacin) • Vitamin B_5 (pantothenic acid) • Vitamin B_6 (pyridoxine) • Vitamin B_7 (biotin) • Vitamin B_9 (folate) • Vitamin B_{12} (cobalamin) • Vitamin C (ascorbic acid)
Sources	• mostly diet • Intestinal flora: little amounts of vitamin K are synthesized by intestinal bacteria	• Mainly diet • Intestinal flora: small amounts of vitamin B_7, B_9, and B_{12} are synthesized by intestinal bacteria

	Fat-soluble vitamin	Water-soluble vitamin
	• Vitamin D is mainly synthesized in the body	
Amalgamation	• Absorption depends on intestinal and pancreatic function • need lipids for absorption	• Absorption in the intestine via exact luminal transporters
Storage	• Can be stored for extended periods of time in the liver and adipose tissue	• **Not stored** in the body, except vitamins B_9 and B_{12}, which are stored in the liver • Hepatic stores of B9 last for approx. 3-4 months, while hepatic stores of B12 last for approx. 3-4 years.
Functions	Function primarily as • Hormones (vitamin D) • Antioxidants (e.g., vitamin E) • Cell signaling (e.g., vitamin A) • Gene transcription (e.g., vitamins A and E)	Function primarily as • **Coenzymes** and precursors to organic cofactors in various chemical reactions (e.g., B vitamins) • Antioxidants (vitamin C)
Deficiency	Causes comprise • Malnutrition • **Malabsorption** syndromes with steat orrhea (**cystic fibrosis and celiac disease**) • Bile acid deficiency (e.g., cholestasis, bile acid malabsorption)	Causes include • Restricted diet (e.g., vegan diet) • Malabsorption disorder (e.g., gastritis, following gastric resection) • Congenital disorders (e.g., Hartnup disease) • Deficiency of **B-complex** often causes **glossitis, dermatitis, and diarrhea**

	Fat-soluble vitamin	Water-soluble vitamin
	• Medications or supplements (e.g., orlistat, mineral oil) • Genetic disorders (e.g., hereditary forms of rickets)	
Overload	• **overload accumulation is probable** (due to oversupplementation) → toxicity	• accretion and following **toxicity are exceptionally rare** • No toxicity has been described for vitamins B_1, B_2, B_5, B_7, B_9, and B_{12}

Chapter-7

Nucleic Acids

These are vital organisms found in the nucleus and cytoplasm. They control the vital biosynthetic functions of the cell and carry genetic information from generation to generation.

Therefore, nucleic acids in macromolecules are essential for biological significance.

They are associated with chromosomes and transmit various details to the cytoplasm.

All the genetic (genetic) details of a cell (that is, all the information needed to reproduce and preserve a new body) are stored in code-encoded DNA molecules. DNA is duplicated and distributed to girls in cells during cell division, and in this way all the information accumulated over the billions of years of evolution is passed from one cell to another from one generation to the next.

With the help of RNA, this information is definite as specific patterns of protein synthesis. These nucleic acids are of two types: (i) deoxyribonucleic acid (DNA) and (ii) ribonucleic acid (RNA). DNA is a vast storehouse of genetic information. This information is transmitted by writing in RNA molecules, proteins, and then processed into a process that involves the translation of RNA.

DNA → transcription RNA→ translation Protein

In higher cells DNA is found mainly in the nucleus as part of chromosomes. A small amount of DNA is present in the cytoplasm and is contained within mitochondria and chloroplasts. RNA is found in both the nucleus, where it is fused, and in the cytoplasm, where proteins are made.

Nucleic acids contain sugar (pentose), nitrogenous bases (purines and pyrimidines), and phosphoric acid. The nucleic acid molecule is a direct polymer in which nucleotides are linked together using phosphodiester 'bridges' or bonds.

These bonds connect 3 'carbon in a single nucleotide pentose and 5' carbon in a nearby nucleotide pentose. The nucleic acid nucleus thus contains the exchange of phosphates and pentoses. Nitrogen bases are attached to the sugar of this spine.

Nucleic acids are basophilic, that is, they are easily stained with basic dyes. After gentle hydrolysis the nucleic acids decompose into nucleotides.

[I] Deoxyribonucleic acid (DNA):

It forms about 9% part of the nucleus as obtained by spectrophotometric analysis. Chemically it consists mainly of three components: phosphoric acid, sugar, and bases.

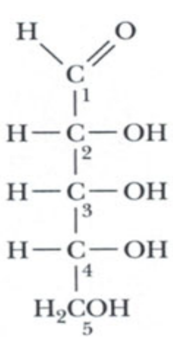
1. Phosphoric acid:

It can also act as phosphate and form the nucleus of the DNA molecule and the sugar molecule. It binds to the nucleotides by joining the deoxyribose (pentoss sugar) of two nucleotides close to the ester-phosphate bond. These bonds bind carbon 3 'to one nucleotide and carbon 5' respectively. This acid is the chemical energy channel used by a molecule.

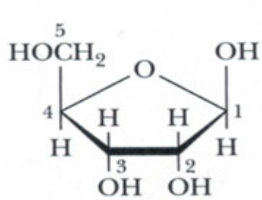
2. Pentoses:

There are two types: ribose in RNA and deoxyribose in DNA. DNA contains a single oxygen atom that is less than RNA. The pentose sugar in nucleic acids is always ribose-, in RNA it is D-ribose and in DNA, it is deoxyribose. OH remains in C-l carbon which is the point of attachment of the foundation.

This is linked to the 1-nitrogen atom in the case of pyrimidines and the 9-nitrogen atom to the purines. Both deoxyribose and ribose (pentose sugar nucleic acid) have a pentagon ring with five carbon, two of which (i.e., 3 and 5 ') are attached to phosphoric acid and three (Γ) to the base.

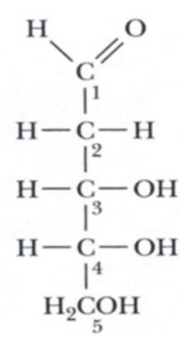


D-Ribose

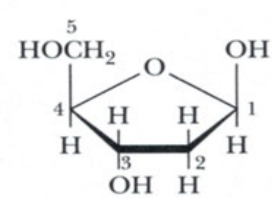


Furanose form of D-Ribose

β-D-Ribofuranose



D-2-Deoxyribose



Furanose form of D-2-Deoxyribose

β-D-2-Deoxyribofuranose

3. Bases:

These may be of two types:

(a) Purines and

(b) Pyrimidines.

(a) Purines:

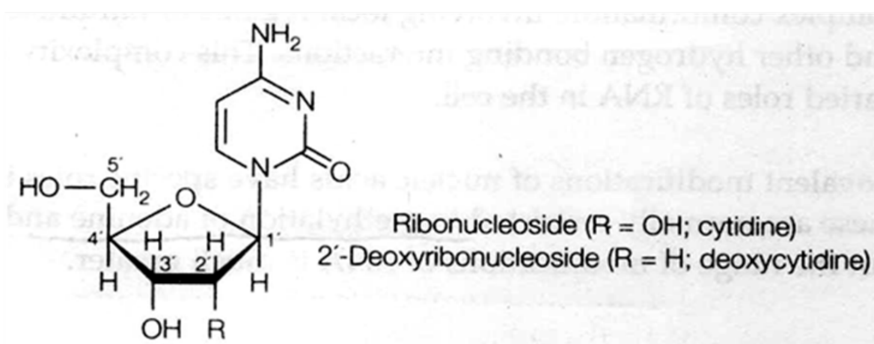
This is evidenced by the presence of two benzene rings combined. It can be adenine (A) and guanine (G). RNA contains uracil (U) instead of thymine. The combination of base and pentose, extracted from phosphate, forms nucleoside. For example, adenine is the basis of purine; adenosine (adenine + ribose) is a compatible nucleoside, i.e., deoxyadenosine and deoxyguanosine.

(b) Pyrimidines:

These are characterized by the incidence of single benzene ring. They are thymine (T) and cytosine (C).

1.3 Nucleosides =ribose/deoxyribose + bases

The bases are covalently attached to the 1' position of a pentose sugar ring, to form a nucleoside



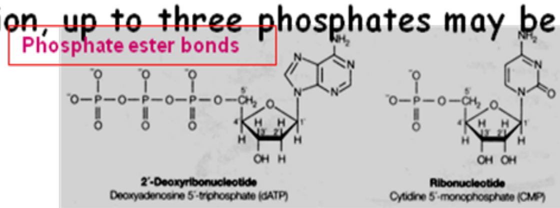
Nucleotides:

Nucleotide phosphate esters are nucleosides, purine or pyrimidine base attached to sugar. In the nucleotides, 3-nitrogen bases of pyrimidine or 9-N purine bases are attached to 1-carbon atom sugar, while phosphoric acid residues are attached to 5 'carbon atoms of sugar.

Consequently the nucleotides of purines are deoxyriboadenylic acid and deoxyriboguanylic acid, and pyrimidines are deoxyribothymidylic acid and deoxyribocytidylic acid.

1.4 Nucleotides = nucleoside + phosphate

- A nucleotide is a nucleoside with one or more phosphate groups bound covalently to the 3′-, 5′, or (in ribonucleotides only) the 2′-position. In the case of 5′-position, up to three phosphates may be attached.



Deoxynucleotides (containing deoxyribose) Ribonucleotides (containing ribose)

BASES	NUCLEOSIDES	NUCLEOTIDES
Adenine (A)	Adenosine	Adenosine 5’-triphosphate (ATP)
	Deoxyadenosine	Deoxyadenosine 5’-triphosphate (dATP)
Guanine (G)	Guanosine	Guanosine 5’-triphosphate (GTP)
	Deoxyguanosine	Deoxy-guanosine 5’-triphosphate (dGTP)
Cytosine (C)	Cytidine	Cytidine 5’-triphosphate (CTP)
	Deoxycytidine	Deoxy-cytidine 5’-triphosphate (dCTP)
Uracil (U)	Uridine	Uridine 5’-triphosphate (UTP)
Thymine (T)	Thymidine/ Deoxythymidie	Thymidine/deoxythymidie 5’-triphosphate (dTTP)

[II] DNA:

Purines and pyrimidines are weak foundations. Nearby nucleotide nucleic acids are connected by a link between the phosphoric acid residue of one nucleotide and the 3 'carbon atom of sugar in the next nucleotide. Both foundations and sugar have an equal structure. In polynucleotides the planes are oriented in an angle of 70 ° to 75 °.

In addition to the four basic elements, DNA is found in many unusual forms. Animal DNA contains the sequence of 5-methy-lcytosine, while a large amount of this base is found in plant DNA. Similarly, 6-methyl aminopurine is derived from DNA from bacteria and viruses.

Cytosine in the DNA of the T-even bacteriophages of E-coli is replaced by 5-hydroxymethylcytosine, where glucose or other sugars can be attached to the hydroxyl group. In some viral DNA's, the rare base 5-hydroxy— methyluracil substitutes for thymine.

[III] DNA base composition:

DNA in living organisms is found as precise molecular weight molecules. For example, E-coli is a single round molecule of DNA weighing about 2.7 × 109 dalton and its length is 1.4 mm. In higher beings the amount of DNA can multiply by several thousand times. For example, in a single human cell a diploid has a total length of 1.7 meters.

All the genetic information of a living being is stored in the order of the four bases. Therefore, the four letters of the alphabet (A, T, G, C) should write the first structure (e.g., number and sequence of 20 amino acids) of all proteins. The composition of the base varies from one type to another, but in all cases the amount of adenine is equal to the amount of thymine (A = T).

Similarly the quantity of cytosine is equal to guanine (C = G). As a result, the sum amount of purines is equal to the total amount of pyrimidines (i.e., A + G = C + T). On the additional hand, the AT / GC ratio varies seriously between species.

[IV] DNA is double helix:

Based on Wilkins and Franklin and Franklin's X-ray distribution data, Watson and Crick (1953) proposed a DNA model model. It consists of two helical polynucleotide chains on the right that form a double helix around the same central axis. These two strands are antiparallel, meaning their 3 ', 5' phosphodiester links run in different ways. The bases are inserted inside the helix in a plane facing the helical axis.

The two strands are held together by the hydrogen bonds that occur between the two base nodes. Since there is a limited distance between two pentose sugars of different fibers, only base bases can enter the structure.

Two hydrogen bonds are formed between A and T, three are formed between C and G, so the CG pair is more stable than the AT pair. In addition to hydrogen bonds, the hydrophobic bonds established between the integrated bases are essential for maintaining a double helical structure.

The axial sequence of the bases corresponding to a single polynucleotide chain may vary widely, but in other series the sequence must be consistent.

Due to this structure, the order of the foundations in one series, the other chain is commendable. During repetition the two chains are separated and each serves as a template for the creation of a new corresponding chain.

[V] Separation of DNA strands:

The DNA double helix is maintained by weak bonding (i.e., hydrogen bonds and hydrophobic interactions between the combined bases); the two fibers can be separated by heat or alkaline pH. This division is called melting or breaking down DNA. The melting point depends on the AT / GC rating. GC double fracture requires a higher temperature than that of AT pairs.

If the DNA has cooled slightly after skin removal, double helical resuscitation will be restored. This process is called renaturation or annealing and these are the basic nucleotide pairs.

DNA sequencing can be used to measure the size (number of nucleotides) of a given genome genome. The larger genome (e.g., calf) takes longer to regenerate than the smaller genome (e.g., E. coli). This is because each sequence takes a long time to find the right partners.

One bound DNA will also reduce the recommended RNA, resulting in a hybrid molecule in which one strand is DNA and the other RNA. Molecular synthesis is the most powerful way to separate RNA from RNA; the molecule will only mix with the DNA where it was transcribed.

[VI] Ribonucleic acid (RNA):

RNA is found in large amounts in the nucleolus and is found in small amounts in chromosomes. The majority of RNA cells are in the cytoplasmic ribosomes. A small amount of RNA is also present in mitochondria and chloroplasts.

Transmission of RNA and mRNA is found in solution in the cytoplasmic matrix without being attached to ribosomes. The RNA content of the nucleus and cytoplasm varies with cell activity cycles. Cytoplasmic RNA increases in size during cell growth prior to mitosis and is evenly distributed between daughter cells.

RNA accumulates in both the nucleus (especially the nucleolus) and cytoplasm during major activity or growth, such as nerve cell regeneration, active neurons, gland cells, viral cells and tumor cells. Active yeast cells contain a large amount of RNA, but hungry yeast cells contain less RNA. Infact, hungry cells generally show a decrease in RNA.

RNA also varies with other body systems such as oxygen deficiency and the presence of metabolic toxins. RNA is active in differentiating cells and functional cells that do not differentiate.

[VII] Structure of RNA:

RNA is a long-chain molecule made up of duplicate nucleotide units connected by 3 to 5 diesel bonds. The RNA sugar is ribose and three of the four bases, adenine, guanine and cytosine are similar to DNA, and the fourth base is uracil instead of DNA thymine, Uracil contains one methyl group lower.

Nucleotides:

RNA nucleotides are comprised of pentose sugar ribose, phosphoric acid and adenine guanine, cytosine or uracil (U). Nucleotides are measured phosphorylated elements of nucleosides. Nucleoside is a basic compound of nitrogenous and pentose sugar without a combined phosphate group.

The nucleotide unit contains a molecule of sugar, base and phosphoric acid. One nucleic acid contains a large number of nucleotide units containing molecular weight (approximately 8,000,000).

Nucleotide is a monomeric unit of nucleic acid macromolecule. The nucleotides are derived from a mixture of phosphate and heterocyclic base containing pentose. Within the nucleotide, a mixture of pentose and pentose forms a nucleoside.

For example, adenine is the basis of purine; adenosine (adenine + ribose) is a compatible nucleoside, while adenosine monophosphate (AMP), adenosine diphosphate (ADP) and adenosine triphosphate (ATP) are nucleotide. Nucleotides, consequently, figure blocks of nucleic acid building blocks and are used to store up and convey chemical energy.

Polynucleotide:

Nucleotides are synthesized to form a polynucleotide series by a combination of phosphoric acid residues of one nucleotide and 3 'carbon dioxide in the next nucleotide. This compound is often called a 3 ', 5' phosphodiester bond, because phosphate is divided into two groups of OH, one attached to 3 'carbon and the other attached to 5' carbon.

The core of the polynucleotide series thus contains interchangeable units of sugar and phosphate.

The sequence of nucleotides in DNA and RNA is key to their genetic functions, just as the sequence of amino acids determines the biological function of a particular protein. Although both DNA and RNA are usually composed of only four nucleotides, the number of possible nucleotide sequences is very large for a large polymer.

RNA is usually present as a single-stranded polynucleotide cable and has no standard helical suspension. Straight sequences are thought to be composed in many ways, with some nucleotides coming together and forming short circuits bound in two.

[VIII] Kinds of ribonucleic acid:

Thre types of ribonucleic acids are—

1.Massenger RNA (m RNA):

This ribonucleic acid originates from the nucleus and transmits genetic information from the DNA in the nucleus to ribosomes in the cytoplasm, where amino acids are collected to form proteins.

2. Transmission or adapter RNA (t RNA):

Another important type of ribonucleic acid present in the cytoplasm, aids in protein synthesis. It was recently discovered that t-RNA originates in the nucleus adjacent to the nucleolar region.

3.Ribosomal RNA (RNA):

This ribonucleic acid is a major component of cytoplasmic particles called ribosomes. Ribosomal RNA contains up to 80% of Escherichia coli cellular RNA. It is an amino acid organization site.

For a detailed composition see chapter-Protein synthesis.

[IX] Importance of nucleic acids:

Deoxyribonucleic acid and ribonucleic acid are important centers that regulate all metabolic functions of the cell and then of all flesh.

(1) In the event of any DNA deficiency, the nucleus loses its ability to support adenosine triphosphate (ATP) synthesis.

(2) Nucleus is also less effective at amino acids in proteins.

(3) In addition, DNA is the basic genetic component of genes and chromosomes that transmit genetic information from one generation to the next. DNA supports the use of RNA in the cell. When traps of the amphibian oocytic chromosome (brush lamp) are exposed to actinomycin (which binds to DNA and causes a decrease in DNA value), RNA synthesis is inhibited.

(4) Recently, McConnell and Cameron (1968) presented evidence that RNA levels increase the intellectual and learning capacity of men.

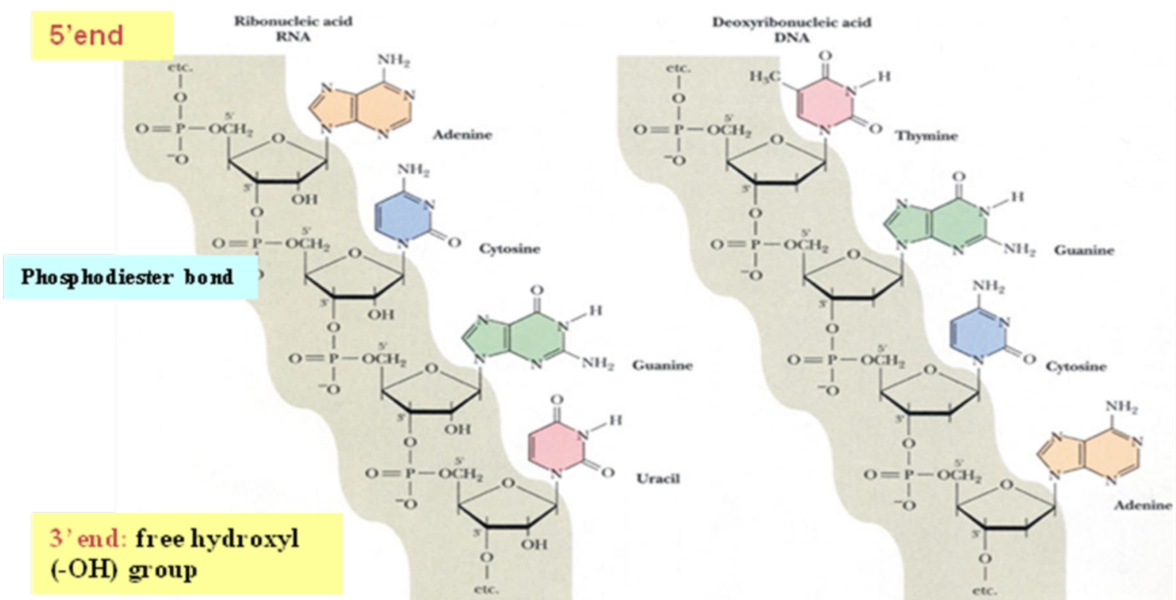
Cellular sequence of nucleic acids:

In deoxyribonucleic acid (DNA), nucleotides are arranged in the form of helixes or chains that wrap around each other. According to Watson and Crick (1962), DNA contains two helixes that are joined together. Each helix series is made up of a group of sugars and phosphate.

These two helixes are connected to the bases by means of hydrogen bonds. Usually one purine is attached to one pyrimidine to form a basic connection between the series. Therefore, adenine and thymine, cytosine and guanine are otherwise linked to the sugar molecule.

The direction of one helix is opposite to the other. In DNA one helix acts as a model for the formation of a coherent helix, i.e., adenine in one helix forms thymine in a new helix and similarly effects cytosine formation of guanine in a new helix.

In ribonucleic acid (RNA), nucleotides are not arranged in a double helical model but a large portion of RNA exists as a single fiber. Sometimes it can also form small helices in some parts due to bending and mixing. These second helical structures in RNA are common according to recent research. In the formation of the helix, the bases become hydrogen-bonded as DNA without uracil substitutes thymine.



Linked Articles:

1. Nucleic Acids: Distribution, Constituents and Structure
2. Relation among Nucleic Acids, Nucleotides and Nucleosides

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