Structure and function of

Non –living inclusions

Macromolecules

Nucleic acids

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Non-living inclusions

Definition: considered as various intracellular non-living substances that can be found within the cytoplasm of the cell, but do not have activity like other organelles. Examples of inclusions are glycogen granules in the liver and muscle cells, lipid droplets in fat cells, pigment granules in certain cells of skin and hair, and crystals of various types.

The cytoplasmic inclusions or non-living cell contents may be classified into the following three main groups:

1. Reserved Products
2. Secretory Products
3. Excretory Products

- **Reserved Products**

The reserved products are formed by various metabolic activities of the cells. These materials are produced and stored in that cell. The reserved products are of the following three main groups:

1. Carbohydrate
2. Proteins
3. Fats or oils

- **Secretory Products**

Various products like nectar, coloring material (pigments), hormones and enzymes, etc. which are secreted by the cells, are called secretory products.

- **Excretory Products**

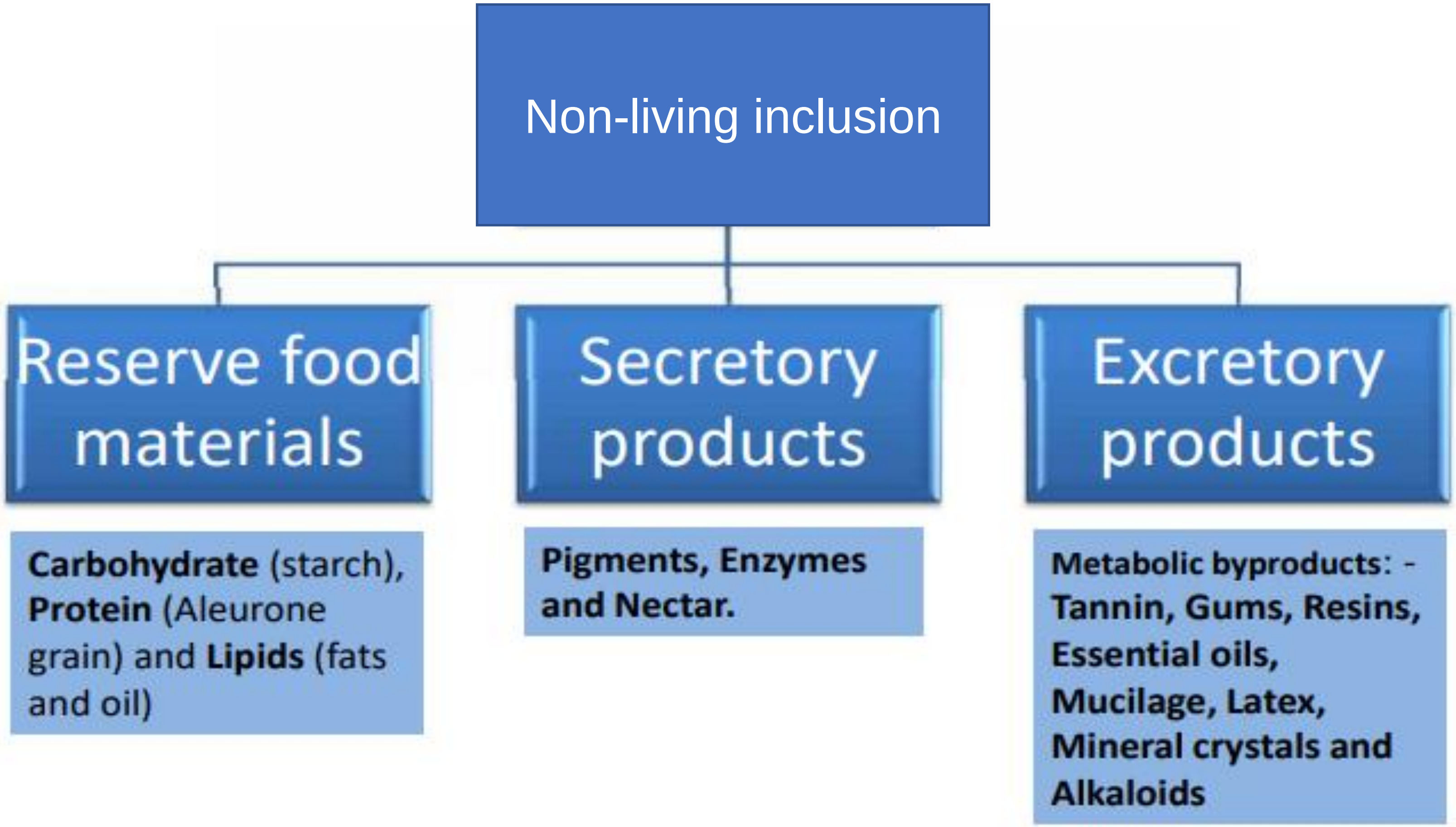
Various harmful products are formed in the cell due to metabolism (metabolic byproducts). These are not secreted but stored in the cytoplasm of the cell. These are known as excretory products of the cell. These products are useful to humanity. Like gum and essential oil

Classified into two:

- Nitrogenous waste products • Alkaloids
- Non-nitrogenous waste products • Gums • Resins • Essential oils • Latex • Mineral crystals

- **Some Functions of Cytoplasmic Inclusions**
- These substances aid the organism in defense.
- It does maintenance of the cellular structure.
- It helps to store various materials.
- Some inclusions such as hormones, enzymes, etc. influence the metabolism, growth, and development of animal and plant bodies.
- Inclusions like nectar attract the insects for pollination.
- Tannins of plants play a role in protection from predation and might help in regulating plant growth.
- The resin of plants protects the plant from pathogens and insects.

Classification of Non-living inclusion



Biological macromolecules

Definition: are important cellular components and perform a wide rang of functions necessary for the survival and growth of living organisms. There are four major classes of biological macromolecules:

1. Carbohydrates
2. Lipids
3. Proteins
4. Nucleic Acids

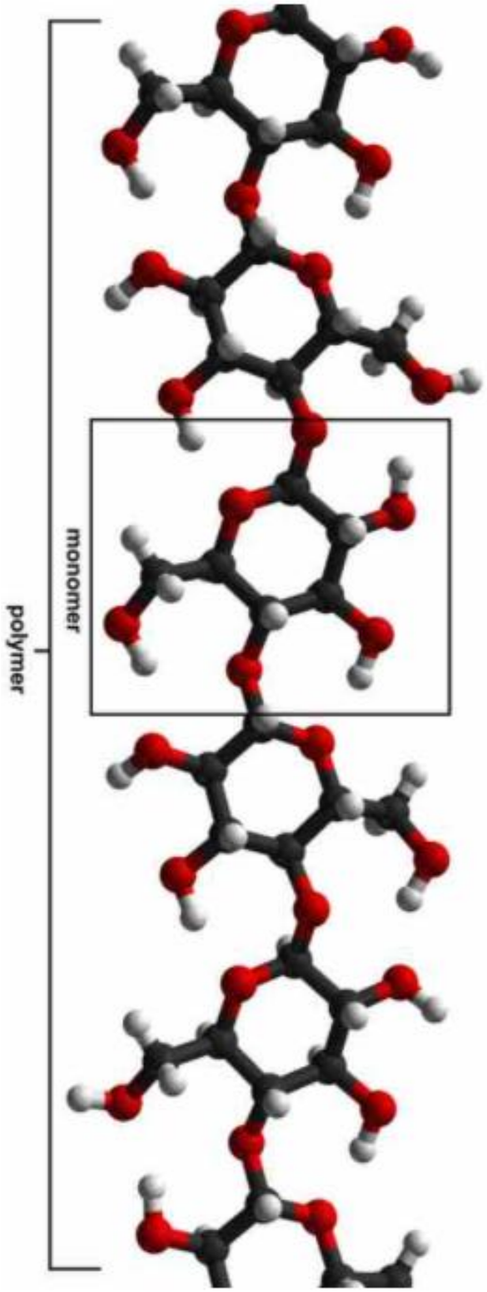
Biological macromolecules all contain carbon in ring or chain form, which means they are classified as organic molecules. They usually also contain hydrogen and oxygen, as well as nitrogen and additional minor elements.

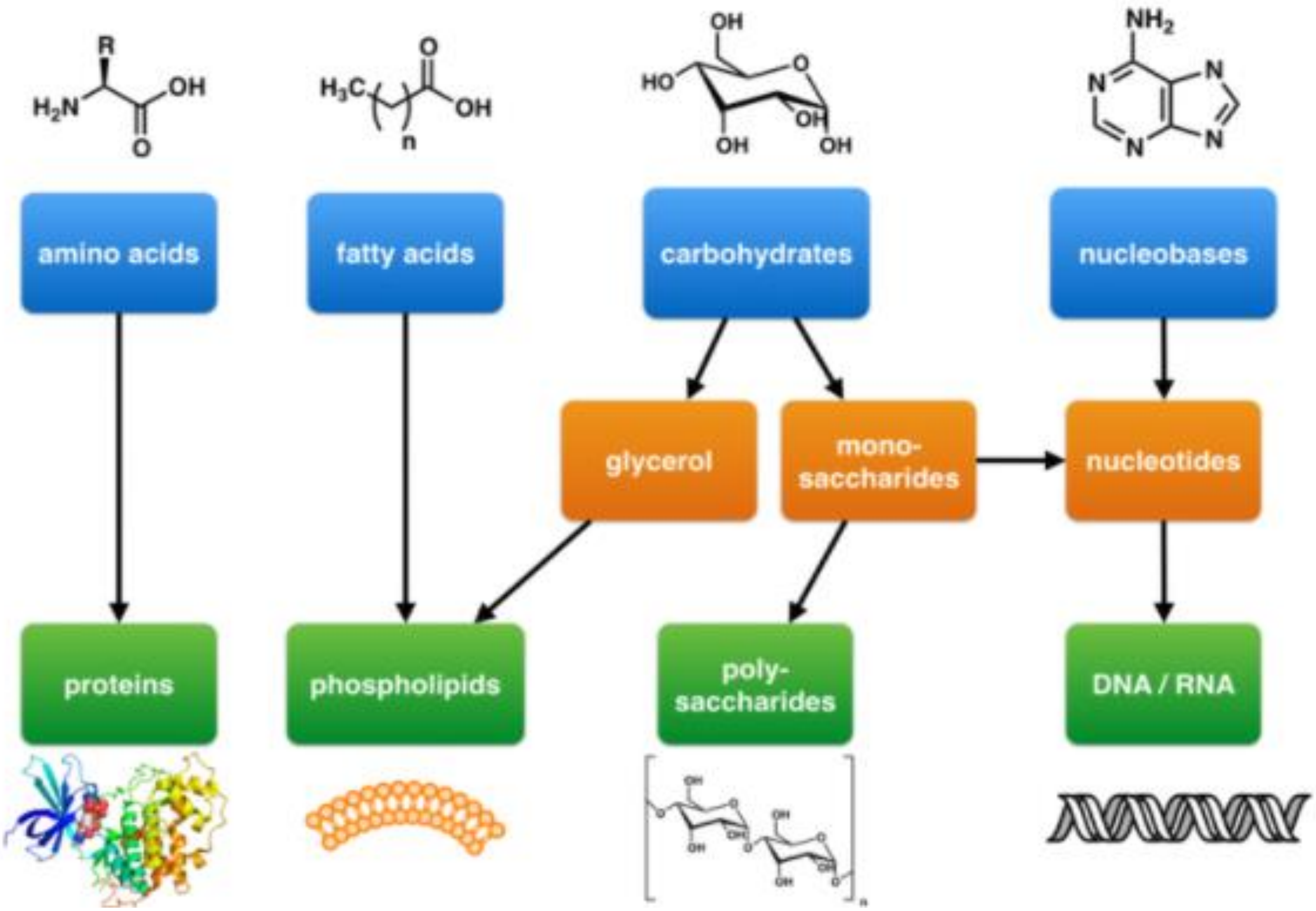
Each different type of macromolecule, except lipids, is built from a different set of monomers that resemble each other in composition and size, and they are linked together into long chains called polymers.

Lipids are not polymers, because they are not built from monomers (units with similar composition).

Monomer:A small molecule that can form covalent bonds with other molecules of the same type to form a polymer. For example, an amino acid acts as the building blocks for proteins.

Polymer:A large molecule made of chain or network of many identical or similar monomers chemically bonded to each other. For example, a carbohydrate is a polymer that is made of repeating monosaccharides.

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amino acids
fatty acids
carbohydrates
nucleobases
glycerol
mono-
saccharides
nucleotides
proteins
phospholipids
poly-
saccharides
DNA / RNA

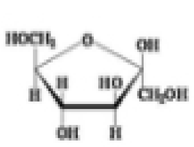
Biological macromolecule	Building blocks	Functions	Examples
Carbohydrates (synonym of **saccharide)**	Monosaccharides (simple sugars)	Provide cells with quick/short-term energy, source of dietary fiber, structure of cell wall	Glucose, sucrose, starch, cellulose, chitin
Lipids	Fatty acids and glycerol	Provide cells with long-term energy, make up biological membranes, insulator	Fats, phospholipids, waxes, oils, grease, steroids
Proteins	Amino acids	Provide cell structure, send chemical signals, speed up chemical reactions, defense, etc	Keratin (found in hair and nails), hormones, enzymes, antibodies
Nucleic acids	Nucleotides	Store and pass on genetic information	DNA, RNA

- **Carbohydrates**

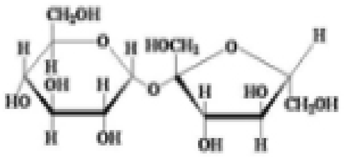
Carbohydrates are neutral organic compounds that are made up of carbon(C), hydrogen (H), and oxygen (O) ions. Carbohydrates are classified into three types:

- Monosaccharide, which contains one molecule of sugar, ex. Glucose, fructose
- Oligosaccharide (disaccharides), which contains 2-10 molecules of sugars, ex sucrose, lactose
- Polysaccharide, which contains more than ten molecules of sugars, ex. Starch, cellulose, glycogen

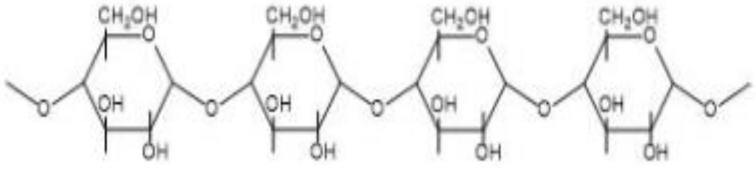
These monosaccharides and disaccharides are all soluble sugars that remain dissolved in the cytoplasm, while hemicelluloses are insoluble polysaccharides found in plant cells. Glycogen is a soluble polysaccharide found in animal cells.



Fructose



Sucrose



Starch

- **Protein**

It is an organic compound which is generally made up of carbon(C), hydrogen (H), oxygen (O) and nitrogen (N), sometimes it also contains sulfur (S) and phosphorus(P). These elements form amino acids, the unit of protein. Proteins are classified into three groups:

- pure protein.
- conjugated protein.
- derived protein.

Some proteins are soluble in water, and some are insoluble in water. Insoluble protein, particles remain scattered within the cytoplasm, which is known as proteid grains.

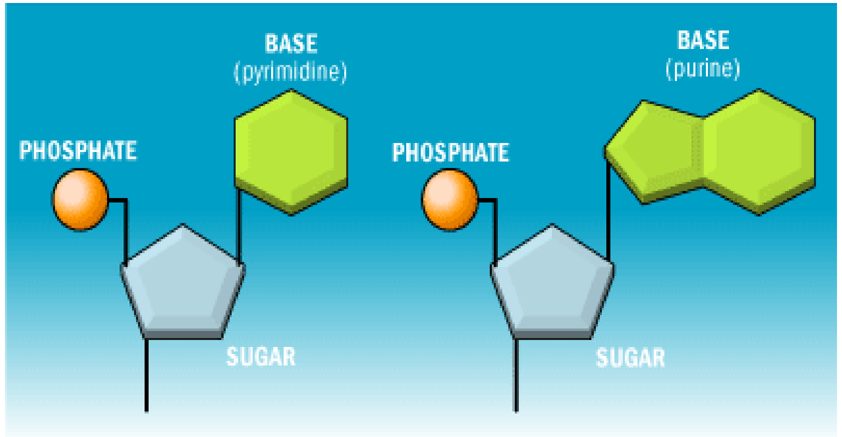
- **Lipid**

Fats are an ester of fatty acids and glycerol. Both are made up of carbon, hydrogen, and oxygen. In animals, fats are mostly stored in fat cells of connective tissue. The big fat droplets occupy almost the whole of the cell. The cytoplasm and nucleus are pushed out to one side. In plants, fats are generally stored in the seeds.

- **Nucleic acids**

Are the biopolymers, essential to all known forms of life. The term *nucleic acid* is the overall name for DNA and RNA. They are composed of nucleotides, which are the monomers made of three components: a 5-carbon sugar (ribose or deoxyribose), a phosphate group and a nitrogenous base (purines or pyrimidines). If the sugar is a compound ribose, the polymer is RNA (ribonucleic acid); if the sugar is derived from ribose as deoxyribose, the polymer is DNA (deoxyribonucleic acid). Nucleic acids are naturally occurring chemical compounds that serve as the primary information-carrying molecules in cells. Also play an especially important role in directing protein synthesis.

Nucleic acid



Nucleic acids are molecules that store information for cellular growth and reproduction. Is one of the four major types of macromolecules that are essential for all known forms of life.

Nucleic acids are of two types:

- Deoxyribonucleic acid (DNA)
- Ribonucleic acid (RNA)

Nucleic acids have polynucleotides that have nucleotides as their building blocks.

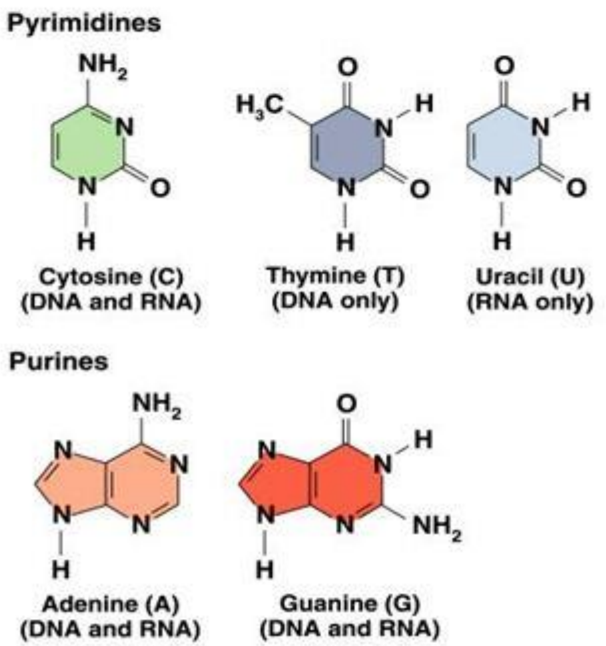
Nucleotides are complex structures which consist of 3 essential components:

- A phosphate group
- A sugar (ribose or deoxyribose)
- A nitrogen base (purines or pyrimidines):

The purines involve Adenine (A) and Guanine(G)

while the pyrimidines are Cytosine(C), Thymine (T) (in DNA) and Uracil (U) (in RNA).

Nitrogen Bases



DNA (Deoxyribonucleic acid)

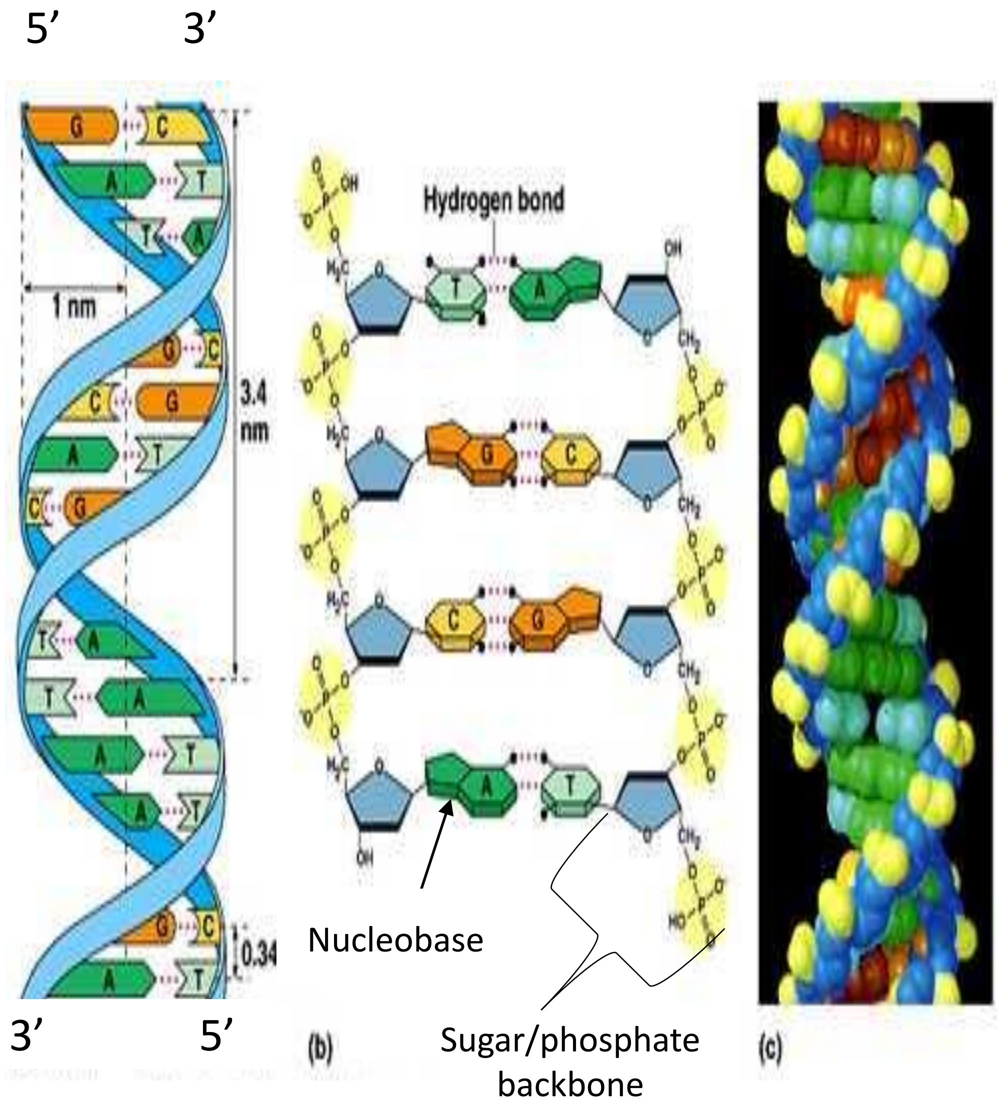
It is the genetic material of the body. It carrying genetic instructions for the development, functioning, growth and reproduction of all known organisms and many viruses. It is also the hereditary factor due to which the genes are passed from one generation to another and so on.

DNA molecules are double-stranded helices, consisting of two long biopolymers made of simpler units called nucleotides—each nucleotide is composed of a nucleobase (guanine, adenine, thymine, and cytosine), recorded using the letters G, A, T, and C, as well as a backbone made of alternating sugars (deoxyribose) and phosphate groups (related to phosphoric acid), with the nucleobases (G, A, T, C) attached to the sugars by covalent bond and the phosphate of the next.

The two strands of DNA are complementary and anti-parallel that means the direction of one strand is 5'-3' while the other strand is 3'-5'.

The order of the bases is important as it determines the genetic information of the molecule.

These bases form double or triple hydrogen bonds (HB) with the opposing bases on the opposite strand of DNA molecule thus forming a double helical structure. Purines always pair with pyrimidines. That means Cytosine pairs with Guanine by triple HB and Adenine pairs with Thymine by double HB



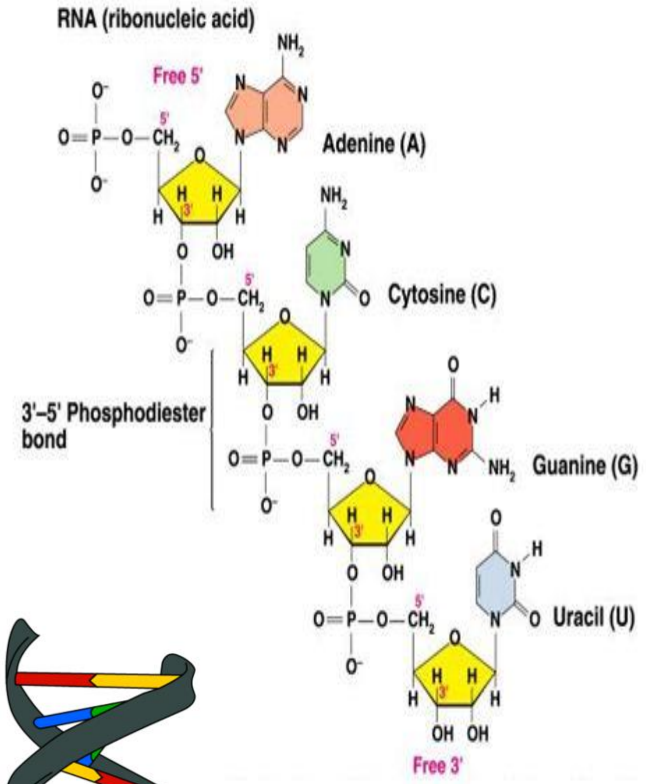
RNA (Ribonucleic acid)

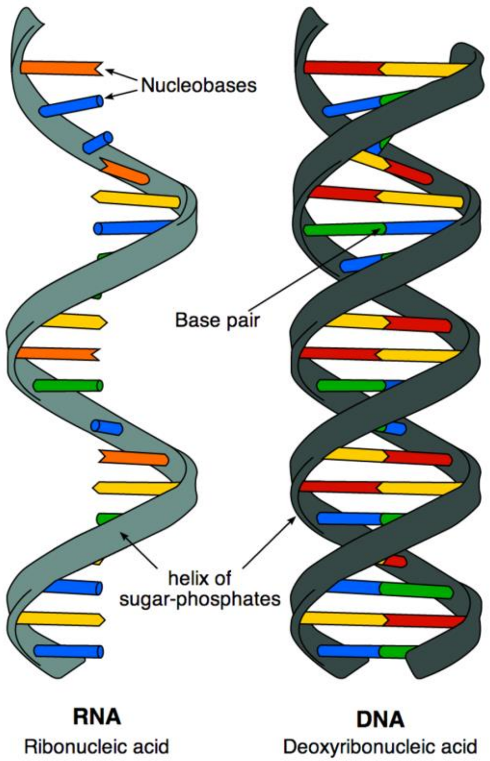
Is a polymeric molecule essential in various biological roles in coding, decoding, regulation and expression of genes.

RNA is a single-stranded molecule. While the sugar-phosphate "backbone" of DNA contains *deoxyribose*, RNA contains *ribose* instead. Ribose has a hydroxyl group attached to the pentose ring in the 2' position, whereas deoxyribose does not. The hydroxyl groups in the ribose backbone make RNA more chemically labile than DNA by lowering the activation energy of hydrolysis.

The complementary base to adenine in DNA is thymine, whereas in RNA, it is uracil, which is an unmethylated form of thymine.

- **There are three major types of RNA:**
  ~ r RNA - Ribosomal RNA (part of ribosome, cellular machines, synthesize proteins from the mRNA templates)
  ~ m RNA - Messenger RNA (encodes AA sequence of one of more polypeptides from a gene or set of genes)
  ~ t RNA - Transfer RNA (reads info. in mRNA and transfers appropriate AA to growing peptide chain)





Homework

- Where can you find,(protein, phospholipid, polysaccharides), in cell structures?
- What are the percentage ratio of protein, lipid, carbohydrates and nucleic acids in the cell?
- What are the living and non-living substances in the cell? Define and Give an example for each.
- What are the coloring material (pigments) in secretory non-living inclusion? Give an example.
- What we mean when we say (excretory products are useful to humanity)? Discuss and give an example.
- What are the most important difference characteristics between DNA and RNA?
- Why DNA double strand is antiparallel (one backbone being with 3′ and the other being with 5′)?

Thanks for attention

Questions