SNS COLLEGE OF TECHNOLOGY

AN AUTONOMOUS INSTITUTION

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COIMBATORE

DEPARTMENT OF CIVIL ENGINEERING

19GET277 – BIOLOGY OF ENGINEERS

IV YEAR / VII SEMESTER

UNIT 1- INTRODUCTION TO LIFE

INTRODUCTION TO BIOMOLECULES

- Biomolecules, also known as biological molecules or macromolecules, are the building blocks of life and form the basis of all living organisms.
- They are large, complex molecules that are essential for various biological processes and functions.
- Biomolecules are primarily composed of carbon atoms, along with other elements such as hydrogen, oxygen, nitrogen, and phosphorus.
- These molecules play critical roles in the structure, function, and regulation of living organisms.

TYPES OF BIOMOLECULES

Carbohydrates: Carbohydrates are organic compounds composed of carbon, hydrogen, and oxygen in a ratio of 1:2:1. They serve as a primary source of energy for living organisms. Common examples of carbohydrates include glucose, sucrose, starch, and cellulose. Carbohydrates also have structural roles, as seen in the cell walls of plants and some organisms.

Lipids: Lipids are a diverse group of biomolecules that are primarily composed of carbon and hydrogen atoms. They are hydrophobic (water-insoluble) and include fats, oils, phospholipids, and steroids. Lipids are essential for energy storage, cell membrane structure, and cell signaling.

TYPES OF BIOMOLECULES

Proteins: Proteins are large, complex biomolecules made up of amino acids. They have a wide range of functions, including enzymatic catalysis, structural support, transport, defense, and signaling. Proteins play a crucial role in the functioning of cells and are involved in nearly every biological process.

Nucleic Acids: Nucleic acids are macromolecules that store and transmit genetic information in living organisms. The two main types of nucleic acids are deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). DNA contains the genetic instructions that determine an organism's traits and characteristics, while RNA plays a role in protein synthesis and other cellular functions.

CARBOHYDRATES

Carbohydrates are organic compounds consisting of carbon, hydrogen, and oxygen atoms, usually in the ratio of 1:2:1. They are one of the essential macromolecules in living organisms and serve as a primary source of energy, as well as playing diverse roles in biological processes.

Carbohydrates can be classified into three main categories based on their structure and complexity:

Monosaccharides: These are the simplest carbohydrates and cannot be broken down further into smaller sugar molecules. Examples include glucose, fructose, and galactose.

CARBOHYDRATES

Disaccharides: Disaccharides are composed of two monosaccharide units linked together through a covalent bond. Common examples include sucrose (glucose + fructose), lactose (glucose + galactose), and maltose (glucose + glucose).

Polysaccharides: Polysaccharides are large molecules composed of multiple monosaccharide units linked together. They are often used for energy storage and structural support. Examples include starch and glycogen (energy storage in plants and animals, respectively), and cellulose (structural component in plant cell walls).

FUNCTION OF CARBOHYDRATE

- Carbohydrates are essential macromolecules that serve a variety of functions in living organisms. Here are some of the main functions of carbohydrates:

Energy Source: Carbohydrates are a primary source of energy for the body. When broken down, they are converted into glucose, which can be readily used by cells to produce ATP (adenosine triphosphate), the energy currency of the cell.

Energy Storage: Excess glucose is stored in the form of glycogen in animals and as starch in plants. These storage forms allow organisms to maintain a steady supply of energy between meals or during times of increased energy demand.

Flavor and Sweetness: Carbohydrates contribute to the taste and sweetness of many foods, making them more palatable and enjoyable.

FUNCTION OF CARBOHYDRATE

Structural Support: Carbohydrates play a structural role in various organisms. In plants, cellulose, a type of carbohydrate, forms the cell walls, providing rigidity and support to the plant cells. Chitin, another carbohydrate, forms the exoskeletons of insects and other arthropods.

Cell Recognition and Signaling: Carbohydrates on the cell surface are involved in cell recognition and signaling processes. They are essential for immune responses, cell adhesion, and communication between cells.

Nucleotide Structure: Carbohydrates are components of nucleotides, which are the building blocks of DNA and RNA. Deoxyribose and ribose, both carbohydrates, are integral parts of these nucleotides.

FUNCTION OF CARBOHYDRATE

Digestive Health: Dietary fiber, a type of carbohydrate found in plant-based foods, helps maintain digestive health by promoting regular bowel movements and preventing constipation.

Brain Function: Glucose, derived from carbohydrates, is a crucial fuel for the brain. The brain's high energy demands make a steady supply of glucose necessary for optimal cognitive function.

Lipid Metabolism: Carbohydrates influence lipid metabolism by affecting insulin levels. Insulin helps regulate blood sugar levels and influences the storage of fats in adipose tissue.

Glycoproteins and Glycolipids: Carbohydrates are attached to proteins (glycoproteins) and lipids (glycolipids) on cell surfaces. These molecules are involved in cell-cell recognition, immune responses, and signaling.

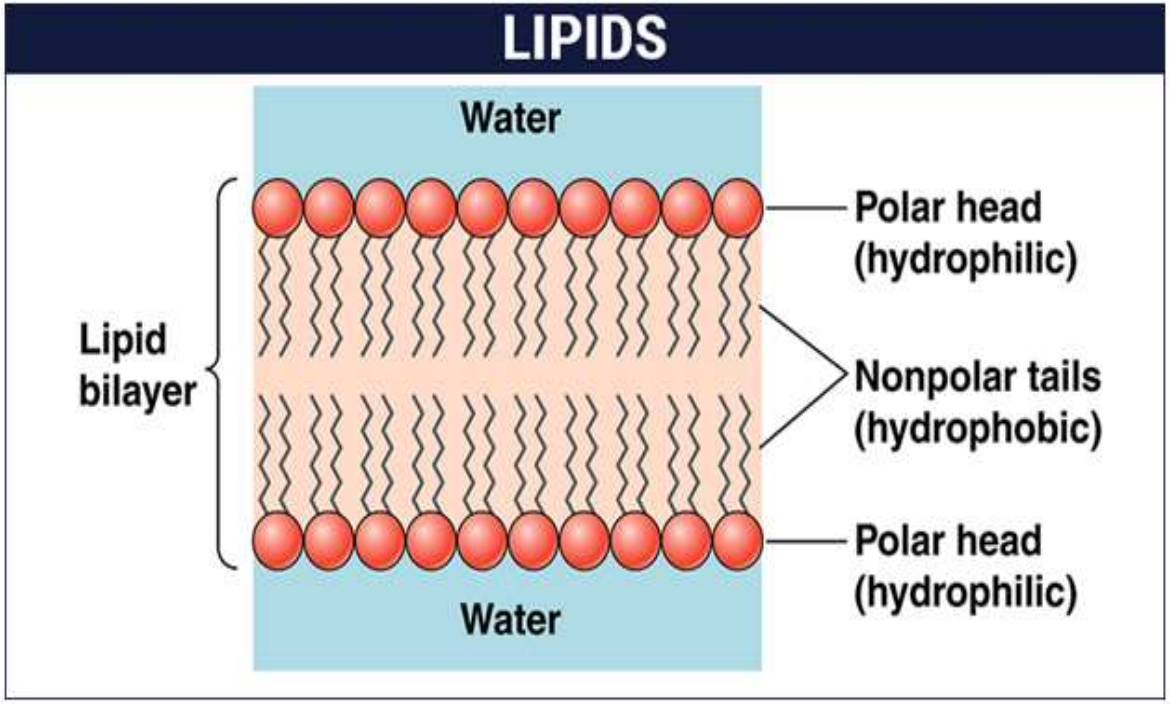
LIPIDS

Any member of a large and diverse group of oils, fat like substances that occur in living organisms and that characteristically are soluble in organic solvents but only sparingly soluble in aqueous solvents.

Chief cellular storage form of energy

Role in cellular structure and biochemical functions.

STRUCTURE OF LIPIDS



PROPERTIES OF LIPIDS

Lipids are a family of organic compounds, composed of fats and oils. These molecules yield high energy and are responsible for different functions within the human body. Listed below are some important characteristics of Lipids.

Lipids are oily or greasy nonpolar molecules, stored in the adipose tissue of the body.

Lipids are a heterogeneous group of compounds, mainly composed of hydrocarbon chains.

Lipids are energy-rich organic molecules, which provide energy for different life processes.

Lipids are a class of compounds characterised by their solubility in nonpolar solvents and insolubility in water.

Lipids are significant in biological systems as they form a mechanical barrier dividing a cell from the external environment known as the cell membrane.

CLASSIFICATION OF LIPIDS

Lipids can be classified into two main classes:

1. Nonsaponifiable lipids

2. Saponifiable lipids

Nonsaponifiable Lipids

A nonsaponifiable lipid cannot be disintegrated into smaller molecules through hydrolysis. Nonsaponifiable lipids include cholesterol, prostaglandins, etc

CLASSIFICATION OF LIPIDS

Saponifiable Lipids

A saponifiable lipid comprises one or more ester groups, enabling it to undergo hydrolysis in the presence of a base, acid, or enzymes, including waxes, triglycerides, sphingolipids and phospholipids.

Further, these categories can be divided into non-polar and polar lipids.

Nonpolar lipids, namely triglycerides, are utilized as fuel and to store energy.

Polar lipids, that could form a barrier with an external water environment, are utilized in membranes. Polar lipids comprise sphingolipids and glycerophospholipids.

Fatty acids are pivotal components of all these lipids.

TYPES OF LIPIDS

Within these two major classes of lipids, there are numerous specific types of lipids, which are important to life, including

1. fatty acids
2. triglycerides
3. glycerophospholipids
4. sphingolipids and
5. steroids.

These are broadly classified as simple lipids and complex lipids.

SIMPLE LIPIDS

Esters of fatty acids with various alcohols.

Fats: Esters of fatty acids with glycerol. Oils are fats in the liquid state

Waxes: Esters of fatty acids with higher molecular weight monohydric alcohols

FATTY ACIDS

Fatty acids are carboxylic acids (or organic acid), usually with long aliphatic tails (long chains), either unsaturated or saturated.

Saturated fatty acids

Lack of carbon-carbon double bonds indicate that the fatty acid is saturated. The saturated fatty acids have higher melting points compared to unsaturated acids of the corresponding size due to their ability to pack their molecules together thus leading to a straight rod-like shape.

Unsaturated fatty acids

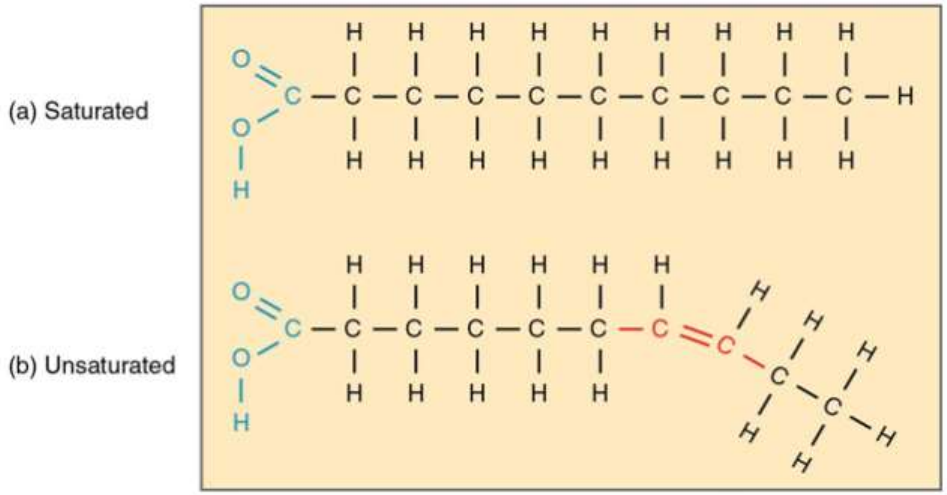
Unsaturated fatty acid is indicated when a fatty acid has more than one double bond.

“Often, naturally occurring fatty acids possesses an even number of carbon atoms and are unbranched.”

On the other hand, unsaturated fatty acids contain a cis-double bond(s) which create a structural link that disables them to group their molecules in straight rod-like shape.

STRUCTURE OF LIPIDS

Lipids are the polymers of fatty acids that contain a long, non-polar hydrocarbon chain with a small polar region containing oxygen. The lipid structure is explained in the diagram below:



Lipid Structure – Saturated and Unsaturated Fatty Acids

ROLE OF FATS

- Fats play several major roles in our body. Some of the important roles of fats are mentioned below:
- Fats in the correct amounts are necessary for the proper functioning of our body.
- Many fat-soluble vitamins need to be associated with fats in order to be effectively absorbed by the body.
- They also provide insulation to the body.
- They are an efficient way to store energy for longer periods.

WAXES

Waxes are “esters” (an organic compound made by replacing the hydrogen with acid by an alkyl or another organic group) formed from long-alcohols and long-chain carboxylic acids.

Waxes are found almost everywhere. The fruits and leaves of many plants possess waxy coatings, that can safeguard them from small predators and dehydration.

Fur of a few animals and the feathers of birds possess the same coatings serving as water repellants.

Carnauba wax is known for its water resistance and toughness (significant for ear wax).

COMPLEX LIPIDS

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

Phospholipids: These are lipids containing, in addition to fatty acids and alcohol, phosphate group. They frequently have nitrogen-containing bases and other substituents, eg, in glycerophospholipids the alcohol is glycerol and in sphingophospholipids the alcohol is sphingosine.

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

Other complex lipids: Lipids such as sulfolipids and amino lipids. Lipoproteins may also be placed in this category.

PRECURSOR AND DERIVED LIPIDS

These include fatty acids, glycerol, steroids, other alcohols, fatty aldehydes, and ketone bodies, hydrocarbons, lipid-soluble vitamins, and hormones. Because they are uncharged, acylglycerols (glycerides), cholesterol, and cholesteryl esters are termed neutral lipids. These compounds are produced by the hydrolysis of simple and complex lipids.

STEROIDS

Our bodies possess chemical messengers known as hormones, which are basically organic compounds synthesized in glands and transported by the bloodstream to various tissues in order to trigger or hinder the desired process.

Steroids are a kind of hormone that is typically recognized by their tetracyclic skeleton, composed of three fused six-membered and one five-membered ring.

CHOLESTEROL

Cholesterol is a wax-like substance, found only in animal source foods. Triglycerides, LDL, HDL, VLDL are different types of cholesterol found in the blood cells.

Cholesterol is an important lipid found in the cell membrane. It is a sterol, which means that cholesterol is a combination of steroid and alcohol. In the human body, cholesterol is synthesized in the liver.

These compounds are biosynthesized by all living cells and are essential for the structural component of the cell membrane.

In the cell membrane, the steroid ring structure of cholesterol provides a rigid hydrophobic structure that helps boost the rigidity of the cell membrane. Without cholesterol, the cell membrane would be too fluid.

It is an important component of cell membranes and is also the basis for the synthesis of other steroids, including the sex hormones testosterone, as well as other steroids such as cortisone and vitamin D.

Thank You!!