Subject Name: Biochemistry

Study stage: First Stage

Lecture title

Chemistry of Lipids

lecture number: 4

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Lipids- Definition, Structure and Functions, Fatty acids

What are Lipids?

Lipids are a group of diverse macromolecules consisting of fatty acids and their derivatives that are insoluble in water but soluble in organic solvents.

- Lipids consist of fats, oils, hormones, and certain components of membranes that are grouped together because of their hydrophobic interactions.
- The lipids are essential constituents of the diet because of their high energy value.
- These are also essential for the fat-soluble vitamins .
- Fats combined with proteins (lipoproteins) are essential constituents of the cell membranes and mitochondria of the cell.
- Lipids occur naturally in living beings like plants, animals, and microorganisms that form various components like cell membranes, hormones, and energy storage molecules.
- These are composed of fatty acids and glycerol.
- Glycerol is a small organic molecule consisting of three hydroxyls (OH-) groups.
- Glycerol makes up simple lipids which are esters of fatty acids and glycerol and similar alcohols.
- The alcohol might be glycerol or other long-chain alcohol. The long-chain alcohols are mostly mono-hydroxy with a single OH group.
- Depending on the alcohol used, simple lipids consist of fats, oil, or waxes. Fats and oils are esters of fatty acids and glycerol, whereas waxes are esters of fatty acids and long-chain alcohols.

Triglycerides

Triglycerides are a type of lipid which is an ester of three fatty acids with glycerol. Triglycerides are the main constituents of body fat in humans.

Structure of Triglycerides

Triglycerides are tri-esters where three fatty acid molecules are bound to a single glycerol molecule by covalent ester bonds.

Functions of Triglycerides

- Triglycerides are important macromolecules as they store most of the energy in the body.
- These are stored in fat cells which are then released into the bloodstream by the action of different hormones.
- The fat stored in the body , which helps to maintain the body temperature.
- Triglycerides also aid in the absorption and transport of fat-soluble vitamins in the body.

What are Fatty acids?

- Fatty acids are organic molecules that are long-chained carboxylic acids with 4-36 carbon atoms.
- The hydrocarbon chains are either saturated or unsaturated, depending on the bonds between the carbon atoms. If all the carbon-carbon bonds are single, the acid is saturated; if one or more carbon-carbon double bonds are present, the acid is unsaturated.

- Naturally occurring fatty acids are mostly branched, and these occur in three main classes of lipids; triglycerides, phospholipids, and cholesterol esters.
- Fatty acids are not found in the free state but remain associated with alcohol to form triglycerides.
- Fatty acids are stored as an energy reserve (fat) through an ester linkage to glycerol to form triglycerides.

Saturated and Unsaturated Fatty acids

1. Saturated fatty acids

- Saturated fatty acids are the simplest form of fats that are unbranched linear chains of CH2 groups linked together by carbon-carbon single bonds with a terminal carboxylic acid.
- Fatty acids obtained from an animal source are mostly even-numbered linear chains of saturated fatty acids.
- Saturated fatty acids usually have a higher melting point than their counterparts which is why saturated fatty acids remain in the solid-state at room temperatures.
- These are mostly solid and are found in animal fat like butter, meat, and whole milk.

2. Unsaturated fatty acids

- Unsaturated fatty acids are more complex fatty acids with bent hydrocarbon chains linked together by one or more carbon-carbon double bonds with a terminal carboxylic acids group.
- The term ‘unsaturated’ indicates that the carbons atoms do not have the maximum possible hydrogen atoms bound to carbon atoms.

- Due to the presence of double bonds, the cis and trans conformation of these molecules are important. The unsaturated fatty acids found in the human body exist in the cis conformation
- Unsaturated fatty acids have a lower melting point as compared to saturated fatty acids, and thus they exist in the liquid state at room temperatures
- Most vegetable oils and fish oils are some of the important sources of unsaturated fatty acids.

Phospholipids

- A phospholipid is an organic molecule consisting of fatty acids, a phosphate group, and a glycerol group that forms the main component of various cellular membranes.
- Phospholipid bilayer forms an important part of the cell membrane for the selective transport of molecules in and out of the cell.
- The phosphate group forms the hydrophilic head, whereas the fatty acids form the hydrophobic tails. The head and tail regions in phospholipids are joined by a glycerol molecule.
- The hydrophobic and hydrophilic interaction between different molecules and the lipid bilayer enables the passage of biomolecules.