Classification of Lipids

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, other vertebrates, and vegetable fats.

Structure of Triglycerides

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

Reaction

HOCH2CH(OH)CH2OH + RCO2H + R'CO2H + R"CO2H → RCO2CH2CH(O2CR')CH2CO2R" + 3H2O

➢ The three fatty acids involved in the condensation reaction are usually different, and their chain length also differs from one another.

➢ In naturally occurring triglycerides, the fatty acid chains mostly contain 16, 18, or 20 carbon atoms.

➢ Even-numbered carbon atoms present in animals and plants indicating the pathway of their biosynthesis from two-carbon acetyl CoA.

➢ Simple triglycerides might also have identical fatty acids forming homotriglycerides.

➢ The charges in triglycerides are evenly distributed around the molecules, which prevents the formation of hydrogen bonds with water molecules, making them insoluble in water.

Triglycerides

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 whenever necessary.

➢ The fat stored in the body forms a layer of insulation beneath the skin, which helps to maintain the body temperature.

➢ Triglycerides also aid in the absorption and transport of fat-soluble vitamins in the body.

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. These interactions make the cell membrane amphipathic.

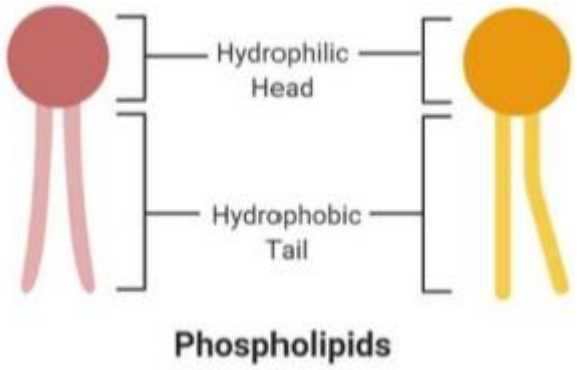
1. Hydrophilic (polar) phosphate heads

➢ The hydrophilic head or water-loving part of the phospholipids contains a negatively charged phosphate group with an unidentified alkyl group.

➢ The hydrophilic region might or might not be polar or charged.

➢ The heads of the phospholipid membrane face outwards that remain in interaction with the aqueous solution inside and outside the cell.

➢ As water is a polar molecule, the hydrophilic head immediately forms electrostatic interaction with the water molecule.



Phospholipids

2. Hydrophobic (non-polar) fatty acid tails

➢ The hydrophobic part of the phospholipid bilayer is also termed the water-fearing portion that consists of long non-polar fatty acid tails.

➢ These tails easily interact with other hydrophobic molecules but do not interact with water molecules.

➢ The tail region is a non-polar end where charge-less molecules are present.

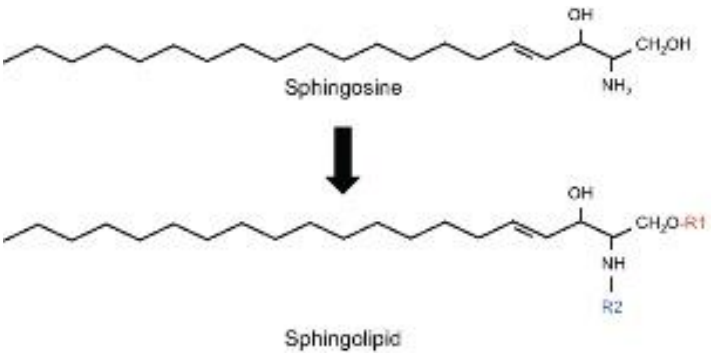
➢ The hydrophobic tails are thus tucked towards the interior of the membrane in order to shield the tails from the surrounding water. This arrangement is also energetically favorable.

➢ The hydrophobic interactions form a good barrier between the inside and outside of the cell as water, and other charge molecules cannot easily cross the hydrophobic core of the membrane.

Sphingolipids

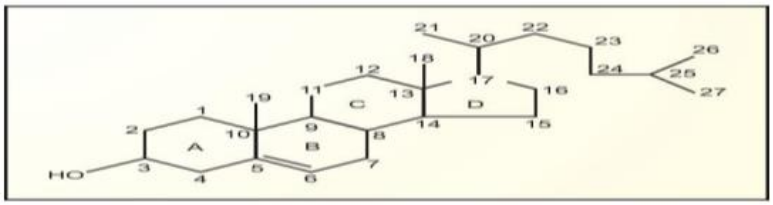
Sphingolipids are diverse group of complex lipids composed of derivatives of sphingosine now called 4-sphingenine which is a long chain amino alcohol formed from palmityl CoA and serine found in brain nerve and tissue. The sphingosine has a long chain fatty acid attached to it amino acid by amide linkage. This is called ceramide, basic structure and in association with phosphoryl choline it forms sphingomyelin. Glycosphingolipids in which

amino alcohol is replaced by sugars. Replacement of phosphoryl choline in sphingomyelin by β-D-galactosyl group. Forms cerebroside.



Cholesterol

Cholesterol, the principal body sterol, is a complex alcohol formed of four fused rings and a side chain, pure cholesterol is a solid at body temperature. The major sites of synthesis of cholesterol are liver, adrenal cortex, testis, ovaries and intestine.



Structure of cholesterol

Approximately 70 % of plasma cholesterol exists in an acyl ester form. The esterification takes place almost exclusively in high density lipoprotein (HDL) complex. Most of the cholesterol in the body is synthesized from acetyl CoA, but we also ingest some when we eat meat, dairy products, or eggplants do not contain cholesterol, although they do have closely related sterols. Cholesterol is catabolized in hepatic cells by oxidation to bile acids (cholic and chenodeoxycholic acids that conjugate with glycine or taurine before secretion into bile. These bile acids and conjugates are emulsifying agents that are essential for the digestion and absorption of fats. Some of cholesterol is also secreted as such into the bile. Both the bile acids and biliary cholesterol are reabsorbed to some extent in the intestine by an entrohepatic circulation. Thus, the liver is the site of cholesterol disposal or degradation, as well as its major sit of synthesis.

A negative feed back mechanism controls to a limited extent the rate of synthesis of cholesterol. When the diet is high in cholesterol, the increased amount of cholesterol brought to the liver decrease the receptors – mediate hepatic intake of cholesterol and inhibits the rate –limiting enzyme (β-hydroxy- β-methylglutaryl CoA reductase) essential for the synthesis of mevalonic acid, step in the synthesis of cholesterol. Furthermore, the reabsorption of bile acids and cholesterol in the enteroheatic circulation is decreased, so more cholesterol is excreted in the form of bile acids and free cholesterol.

Serum cholesterol concentration can rise to high levels in some pathological states. An elevated cholesterol concentration has been implicated as one of sever risk factors leading to coronary artery disease (atherosclerosis or myocardial infraction); thus the measurement of serum cholesterol is a fairly common lab. procedure.

Significance and Functions of Cholesterol:

1. Heart diseases: The level of cholesterol in blood is related to the development of atherosclerosis. Abnormality of cholesterol metabolism may lead to cardiovascular accidents and heart attacks.

2. Cell membranes: Cholesterol is a component of membranes and has a modulating effect on the fluid state of the membrane.

3. Nerve conduction: Cholesterol is a poor conductor of electricity, and is used to insulate nerve fibers.

4. Bile acids and bile salts: The 24 carbon bile acids are derived from cholesterol. Bile salts are important for fat absorption.

5. Steroid hormones: 21 carbon glucocorticoids, 19 carbon androgens and 18 carbon estrogens are synthesized from cholesterol.

6. Vitamin D: It is synthesized from cholesterol.