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S.Y. B.Sc. (Sem. III) (CBCS)

BIOCHEMISTRY

BIOCHEMISTRY-301

Unit - 2

LIPIDS

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CONTENT

- BUILDING BLOCKS OF LIPIDS-FATTY ACIDS, GLYCEROL, CERAMIDE
- CLASSIFICATION OF LIPIDS
- STORAGE OF LIPIDS-TRIGLYCEROL AND WAXES
- SRRUCTURAL LIPIDS IN MEMBRANE
- STEROLS, STRUCTURE, DISTRIBUTION AND ROLE OF MEMBRANE LIPIDS

LIPIDS

- Lipids are a heterogeneous group of water-insoluble (hydrophobic) organic molecules that can be extracted from tissues by nonpolar solvents, because of their insolubility in aqueous solutions, body lipids are generally found compartmentalized, as in the case of membrane associated lipids or droplets of triacylglycerol in adipocytes, or transported in plasma in association with protein, as in lipoprotein particles or on albumin.
- Lipids are a major source of energy for the body, and they provide the hydrophobic barrier.
- Lipids serve additional functions in the body, for example, some fat-soluble vitamins have regulatory or coenzyme functions, and the prostaglandins and steroid hormones play major roles in the control of the body's homeostasis.

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General characters of lipids

- Lipids are relatively insoluble in water. They are soluble in non-polar solvents, like ether, chloroform, and methanol.
- Lipids have high energy content and are metabolized to release calories.
- Lipids also act as electrical insulators; they insulate nerve axons.
- Fats contain saturated fatty acids; they are solid at room temperatures. Example, animal fats.
- Plant fats are unsaturated and are liquid at room temperatures.
- Pure fats are colorless, they have extremely bland taste.
- The fats are sparingly soluble in water and hence are described are hydrophobic substances.
- They are freely soluble in organic solvents like ether, acetone and benzene.
- The melting point of fats depends on the length of the chain of the constituent fatty acid and the degree of unsaturation.
- Geometric isomerism, the presence of double bond in the unsaturated fatty acid of the lipid molecule produces geometric or cis-trans isomerism.
- Fats have insulating capacity; they are bad conductors of heat.
- Emulsification is the process by which a lipid mass is converted to a number of small lipid droplets. The process of emulsification happens before the fats can be absorbed by the intestinal walls.

• The fats are hydrolyzed by the enzyme lipases to yield fatty acids and glycerol.

• The hydrolysis of fats by alkali is called saponification. This reaction results in the formation of glycerol and salts of fatty acids called soaps.

• Hydrolytic rancidity is caused by the growth of microorganisms which secrete enzymes like lipases. These split fats into glycerol and free fatty acids.

Classification of lipids

1.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.

2. Complex lipids: Esters of fatty acids containing groups in addition to an alcohol and a fatty acid.

• Phospholipids: Lipids containing, in addition to fatty acids and an alcohol, a phosphoric acid residue.

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 aminolipids. Lipoproteins may also be placed in this category.

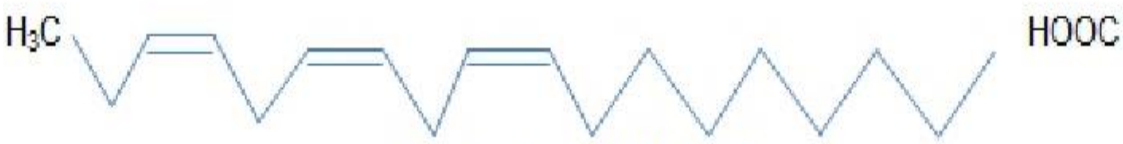
3. Precursor and derived lipids: These include fatty acids, glycerol, steroids, other alcohols, fatty aldehydes, and ketone bodies, hydrocarbons, lipid-soluble vitamins and hormones.

Essential fatty acids

Two fatty acids are dietary essentials in humans.

- Linoleic acid, which is the precursor of arachidonic acid, the substrate for prostaglandin synthesis.
- α-linolenic acid is the precursor for growth and development. Essential fatty acid deficiency can result in a scaly dermatitis, as well as visual and neurologic abnormalities.

Linoleic acid (18:2n-6)



α-Linolenic acid (18:3n-3)

Regulating Blood Cholesterol Levels

• Fats and cholesterol cannot dissolve in blood and are consequently packaged with proteins (to form lipoproteins) for transport.

➢ Low density lipoproteins (LDL) carry cholesterol from the liver to the rest of the body. Hence LDLs raise blood cholesterol levels ('bad') while HDLs lower blood cholesterol levels ('good')

• High intakes of certain types of fats will differentially affect cholesterol levels in the blood

➢ Saturated fats increase LDL levels within the body, raising blood cholesterol levels

➢ Trans fats increase LDL levels and decrease HDL levels within the body, significantly raising blood cholesterol levels

➢ Unsaturated (cis) fats increase HDL levels within the body, lowering blood cholesterol levels.

➢ High density lipoproteins (HDL) scavenge excess cholesterol and carry it back to the liver for disposal.

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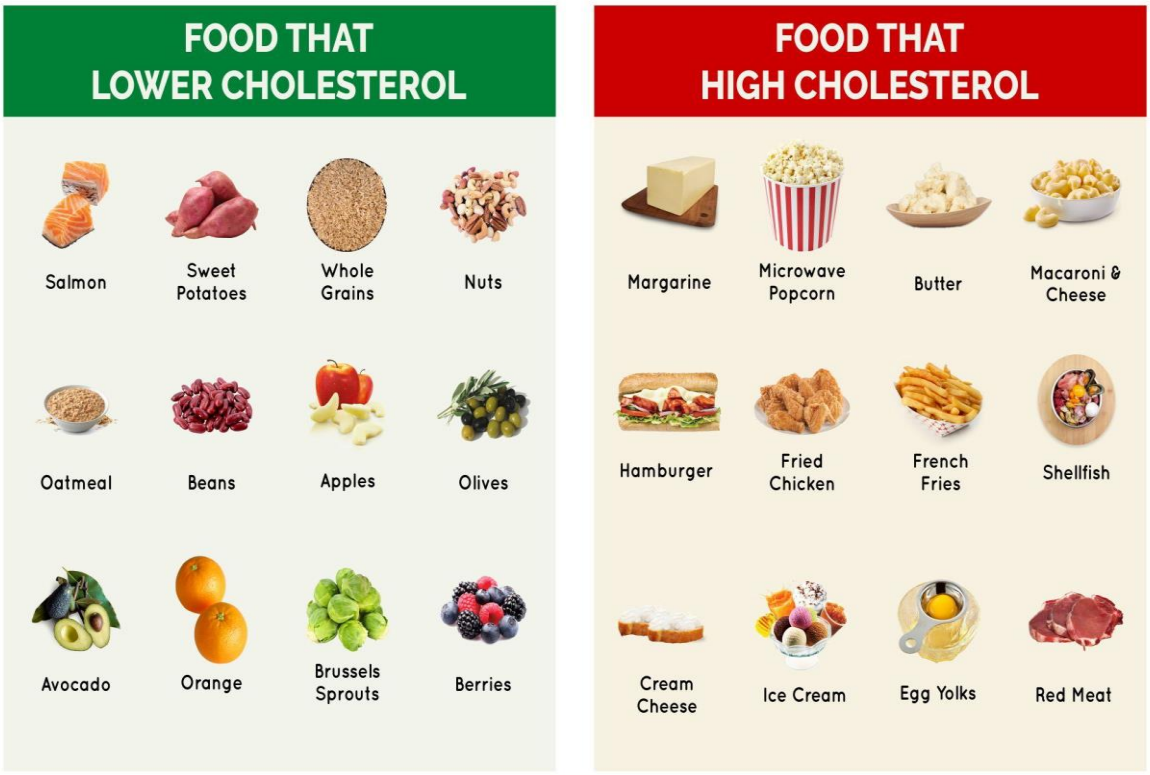

Lipid Health Claims

There are two main health claims made about lipids in the diet:

- Diets rich in saturated fats and trans fats increase the risk of CHD.
- Diets rich in monounsaturated and polyunsaturated (cis) fats decrease the risk of CHD. Health Risks of High Cholesterol
- High cholesterol levels in the bloodstream lead to the hardening and narrowing of arteries (atherosclerosis).
- When there are high levels of LDL in the bloodstream, the LDL particles will form deposits in the walls of the arteries.

• The accumulation of fat within the arterial walls leads to the development of plaques which restrict blood flow.

• If coronary arteries become blocked, Coronary Heart Disease (CHD) will result – this includes heart attacks and strokes.

Examples of Lipids

• Fatty acids - Oleic acid, Linoleic acid, Palmitoleic acid, Arachidonic acid.

• Fats and Oils

➢ Animal fats - Butter, Lard, Human fat, Herring oil.

➢ Plant oils - Coconut oil, Corn, Palm, Peanut, Sunflower oil

. • Waxes - Spermaceti, Beeswax, Carnauba wax.

• Phospholipids - Lecithin, Cephalins, Plasmalogens, Phosphatidyl inositol, Sphingomyelins.

• Glycolipids - Krasin, Phrenosin, Nervon, Oxynervon.

• Steroids - Cholesterol.

• Terpenes - Monoterpenes, Sesquiterpenes, Diterpenes, Triterpenes.

• Carotenoids - Lycopene, Carotenes, Xanthophylls.

BIOLOGICAL ROLE OF LIPIDS

• **Food material**: Lipids provide food, highly rich in calorific value. One gram lipid produces 9.3 kilocalories of heat.

• **Food reserve**: Lipids provide are insoluble in aqueous solutions and hence can be stored readily in the body as a food reserve.

• **Structural component**: Lipids are an important constituent of the cell membrane.

• **Heat insulation**: The fats are characterized for their high insulating capacity. Great quantities of fat are deposited in the subcutaneous layers in aquatic mammals such as whale and in animals living in cold climates. Fatty acid absorption: Phospholipids play an important role in the absorption and transportation of fatty acids.

• **Hormone synthesis:** The sex hormones, adrenocorticoids, cholic acids and also vitamin D are all synthesized from cholesterol, a steroidal lipid.

• **Vitamin carriers**: Lipids act as carriers of natural fat-soluble vitamins such as vitamin A, D and E.

• **Blood cholesterol lowering:** Chocolates and beef, especially the latter one, were believed to cause many heart diseases as they are rich in saturated fatty acids, which boost cholesterol levels in blood and clog the arterial passage. But researches conducted at the University of Texas by Scott Grundy and Andrea Bonanome (1988)

suggest that at least one saturated fatty acid stearic acid, a major component of cocoa butter and beef fat, does not raise blood cholesterol level at all. The researchers placed 11 men on three cholesterol poor liquid diets for three weeks each in random order. One formula was rich in palmitic acid, a known cholesterol booster; the second in oleic acid; and the third in stearic acid. When compared with the diet rich in palmitic acid, blood cholesterol levels were 14% lower in subjects put on the stearic acid diet and 10% lower in those on the oleic acid diet.

• **Antibiotic agent**. Squalamine, a steroid from the blood of sharks, has been shown to be an antibiotic and antifungal agent of intense activity. This seems to explain why sharks rarely contract infections and almost never get cancer.