LIPIDS

Introduction

In biology, **lipids** comprise a group of naturally occurring molecules that include fats, waxes, sterols, fat-soluble vitamins (such as vitamins A, D, E, and K), monoglycerides, diglycerides, triglycerides, phospholipids, and others. The main biological functions of lipids include storing energy, signaling, and acting as structural components of cell membranes. Lipids have applications in the cosmetic and food industries as well as in nanotechnology.

Scientists may broadly define lipids as hydrophobic or amphiphilic small molecules; the amphiphilic nature of some lipids allows them to form structures such as vesicles, multilamellar/unilamellar liposomes, or membranes in an aqueous environment. Biological lipids originate entirely or in part from two distinct types of biochemical subunits or "building-blocks": ketoacyl and isoprene groups. Using this approach, lipids may be divided into eight categories: fatty acids, glycerolipids, g lycerophospholipids, sphingolipids, saccharolipids, and polyketides (derived from condensation of ketoacyl subunits); and sterol lipids and prenol lipids (derived from condensation of isoprene subunits).

Although the term *lipid* is sometimes used as a synonym for fats, fats are a subgroup of lipids called triglycerides. Lipids also encompass molecules such as fatty acids and their derivatives (including tri-, di-, monoglycerides, and phospholipids), as well as other sterol-containing metabolites such as cholesterol. Although humans and other mammals use various biosynthetic pathways both to break down and to synthesize lipids, some essential lipids cannot be made this way and must be obtained from the diet.

Definition

Lipid: Another word for "fat." (Please see the various meanings of fat.) A lipid is chemically defined as a substance that is insoluble in water and soluble in alcohol, ether, and chloroform.

Lipids are an important component of living cells. Together with carbohydrates and proteins, lipids are the main constituents of plant and animal cells.

Cholesterol and triglycerides are lipids. Lipids are easily stored in the body. They serve as a source of fuel and are an important constituent of the structure of cells.

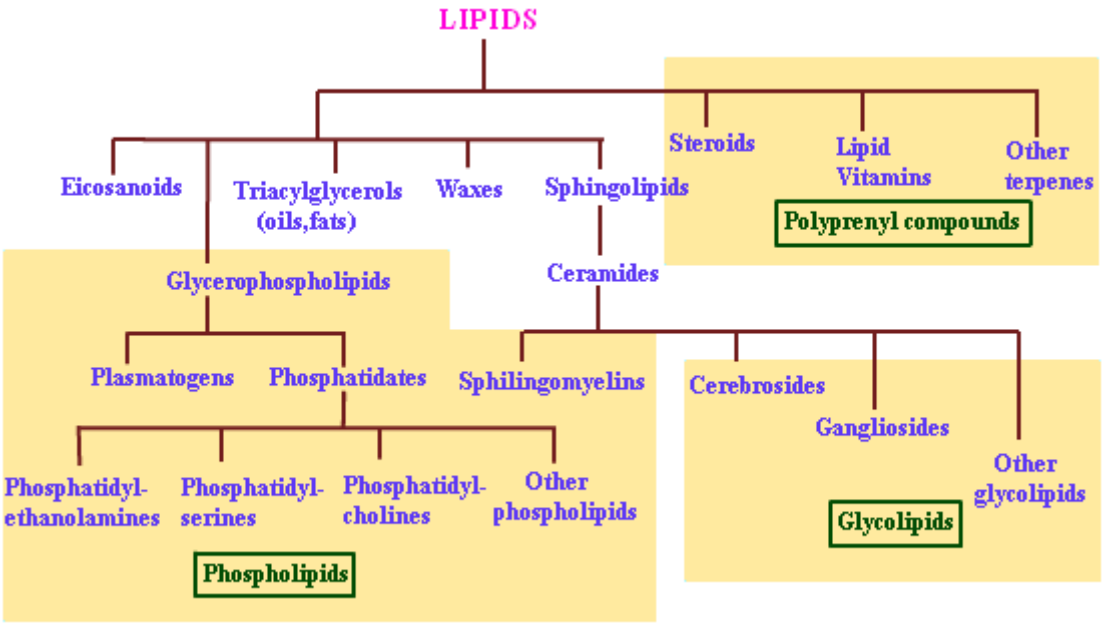
Lipids include fatty acids, neutral fats, waxes and steroids (like cortisone). Compound lipids (lipids complexed with another type of chemical compound) comprise the lipoproteins, glycolipids and phospholipids.

Different Types of Lipids

The classification of lipids can be structural based or based on their functions. **Mainly lipids are classified in five types.**

- **Fatty acyl (FA)**
- **Glycerolipids (GL)**
- **Glycerophospholipids (GP)**
- **Sterol lipids (ST)**
- **Sphengolipids (SP)**

The relation between different types of lipids is as follows.



1. Fatty acyls

- Fatty acyls, a generic term are used for fatty acids and their derivatives.
- The fatty acid composed of one hydrocarbon chain which terminates with a carboxylic acid group.
- The carboxyl end is polar and soluble in water; **hydrophilic**.
- The long hydrocarbon chain is non-polar in nature and hydrophobic.
- The carbon chain in fatty acids can be saturated or unsaturated and can have some other functional groups.
- In case of unsaturated fatty acids, cis-trans isomers can be possible. Cis-fatty acids are found naturally while trans can be synthesized artificially by partial hydrogenation of fats and oils.

2. Glycerolipids (triglycerides)

- They also known as triglycerides or triglycrols which composed of mono-, di- and tri-substituted glycerol.
- They formed by the esterification of glycerols with different fatty acids.
- During fat metabolism, glycerolipids releases glycerol and fatty acids from adipose tissue, thus they function as a food store comprise in the bulk as storage fat in animal tissues.
- Glycosylglycerols is a class of **glycerolipids** which composed of one or more sugar residues with glycerol through a glycosidic linkage and fatty acids.
- The plant membranes having Digalactosyldiacylglycerols and the mammalian sperm containing seminolipid are best example of glycosylglycerols.

3. Glycerophospholipids

- They also called as phospholipids, composed of fatty acids, glycerol with phosphate groups.
- Phospholidis are the main constituents of the lipid bilayer of cells and also are involved in metabolism.

4. Sphingolipids

- These lipids are quite different from first two lipids and more complex compare to them.
- They composed of a sphingoid base backbone which is synthesized from serine; an amino acid and a fatty acyl CoA long-chain.
- This further converted into ceramides, glycosphingolipids, phosphosphingolipids and other compounds.
- Some common examples of sphingolipids are **Ceramides, sphingomyelins**(a phosphosphingolipids) are found in mammals.
- Whereas, ceramide phosphoethanolamines are found in insects and phytoceramide phosphoinositols, mannose-containing headgroups are found in fungi.
- Examples of glycosphingolipids are cerebrosides and gangliosides.

5. Sterol lipids

- These lipids are main components of membrane lipids along with sphingomyelins and the glycerophospholipids.
- The best common examples of sterol are cholesterol and its derivatives.
- Steroids are composed of fused four-ring core structure but show different biological roles such as hormones like estrogen, testosterone and androsterone.
- Some vitamins like vitamin-D also composed of one of the sterol; **secosteroids**.
- Other examples of sterols are bile acids in mammals, phytosterols in plants like Î²-sitosterol, brassicasterol and stigmasterol.

6. Prenol lipids

- These lipids are synthesized from the 5-carbon precursor dimethylallyl diphosphate and the isopentenyl diphosphate.
- The simple isoprenoids are classified according to the terpene units number.
- Carotenoids is a terpene act as antioxidants as well as precursors of vitamin A.
- However if there are more than 40 carbons present in lipids, they are called as polyterpenes.
- If an tail of isoprenoid gets attached to an quinonoid core of non-isoprenoid origin, they are exemplified by the quinones and hydro quinones.

7. Saccharolipids

Those fatty acids which are directly linked with a sugar backbone are known as saccharolipids.

8. Polyketides

- These lipids are synthesized by the polymerization method of acetyl subunit and propionyl subunit in the presence of enzymes which share mechanistic features with the fatty acid syntheses.
- Generally these molecules are cyclic in nature whose backbones are then further modified by hydroxylation, glycosylation, methylation, and oxidation.
- Polyketides are used as anti-microbial, anti-cancer agents and anti-parasitic.
- Some common examples of polyketides are **tetracyclines, avermectins, erythromycins and anti-tumor epothilones**.

Function of Lipids

Lipids perform several biological functions:

- Lipids are storage compounds, triglycerides serve as reserve energy of the body.
- Lipids are important component of cell membranes structure in eukaryotic cells.
- Lipids regulate membrane permeability.
- They serve as source for fat soluble vitamins like A, D, E, K.
- They act electrical insulators to the nerve fibres, where the myelin sheath contains lipids.
- Lipids are components of some enzyme systems.
- Some lipids like prostaglandins and steroid hormones act as cellular metabolic regulators.
- Cholesterol is found in cell membranes, blood, and bile of many organisms.
- As lipids are small molecules and are insoluble in water, they act as signalling molecules.
- Layers of fat in the subcutaneous layer, provides insulation and protection from cold. Body temperature maintenance is done by brown fat.
- Polyunsaturated phospholipids are important constituents of phospholipids, they provide fluidity and flexibility to the cell membranes.
- Lipoproteins that are complexes of lipids and proteins, occur in blood as plasma lipoprotein, they enable transport of lipids in aqueous environment, and their transport throughout the body.
- Cholesterol maintains fluidity of membranes by interacting with lipid complexes.
- Cholesterol is the precursor of bile acids, Vitamin D and steroids.
- Essential fatty acids like linoleic and linolenic acids are precursors of many different types of ecosanoids including prostaglandins, thromboxanes. These play a important role in pain, fever, inflammation and blood clotting.

Characteristics of Lipids

General characters of lipids are

- Lipids are relatively insoluble in water.
- They are soluble in non-polar solvents, like ether, chloroform, 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.

Examples of Lipids

Few well known examples of lipids are as follows:

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 - Spermacti, Beeswax, Carnauba wax.

Phospholipids - Lecithins, Cephalins, Plasmoalogens, Phosphatidyl inositols, Sphingomyelins.

Glycolipids - Kerasin, Phrenosin, Nervon, Oxynervon.

Steroids - C 29, C 28, C 27, C 24, C 21 steroids.

Terpenes - Monoterpenes, Sesquiterpenes, Diterpenes, Triterpenes.

Carotenoids - Lycopene, Carotenes, Xanthophylls.

Advantages and Disadvantages of Lipids

Advantages of lipids

- Roles in Your Body
- Provide Energy
- Absorption of Vitamins
- Few are Essential Fatty Acids for Body

Disadvantages Of lipids

- Raise Your Susceptibility to Heart Disease
- Lead to Weight Gain
- Make You Insulin-Resistant
- Raise Your Cancer Risk

References

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