SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF OPERATION THEATRE & ANESTHESIA TECHNOLOGY

COURSE NAME : BIOCHEMISTRY

TOPIC : LIPIDS

LIPIDS

- Lipids are one of the significant macromolecules present in our bodies.
- They act as structural components of cell membranes, act as energy storage sources, and partake in signaling pathways.
- Lipids are the main energy stockpiling compounds in the set of all animals.
- Plants store the greater part of their energy as carbs, basically as starch.
- Furthermore, lipids give protection to the crucial organs, shielding them from mechanical shock and keeping up with ideal internal heat levels.
- Lipids are necessary parts of cell layer structure and are related to transportation across cell films.

- The term lipid is defined as a family group of heterogeneous organic compounds which are soluble in non-polar solvents.
- Lipids naturally occur in most plants, animals, and microorganisms and are used as cell membrane components, energy storage molecules, insulation, and hormones.
- These chemical features are present in a broad range of molecules such as fatty acids, phospholipids, sterols, sphingolipids, terpenes, and others.
- Structurally, they are esters or amides of fatty acids.
- These molecules can be soluble in non-polar solvents but can’t be soluble in water.

Structure

- Lipids are made up of two molecules, glycerol, and fatty acids.
- Glycerol molecule consists of three carbon atoms with a hydroxyl group attached to it.
- Fatty acids are the long chains of hydrocarbons with a carboxylic acid group at the end.
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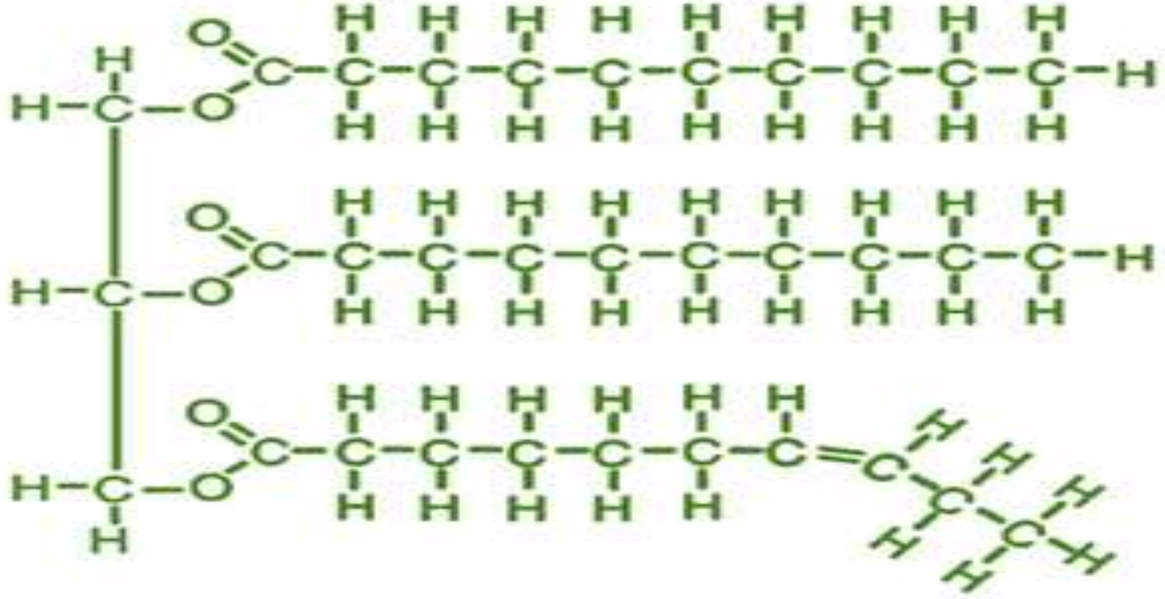
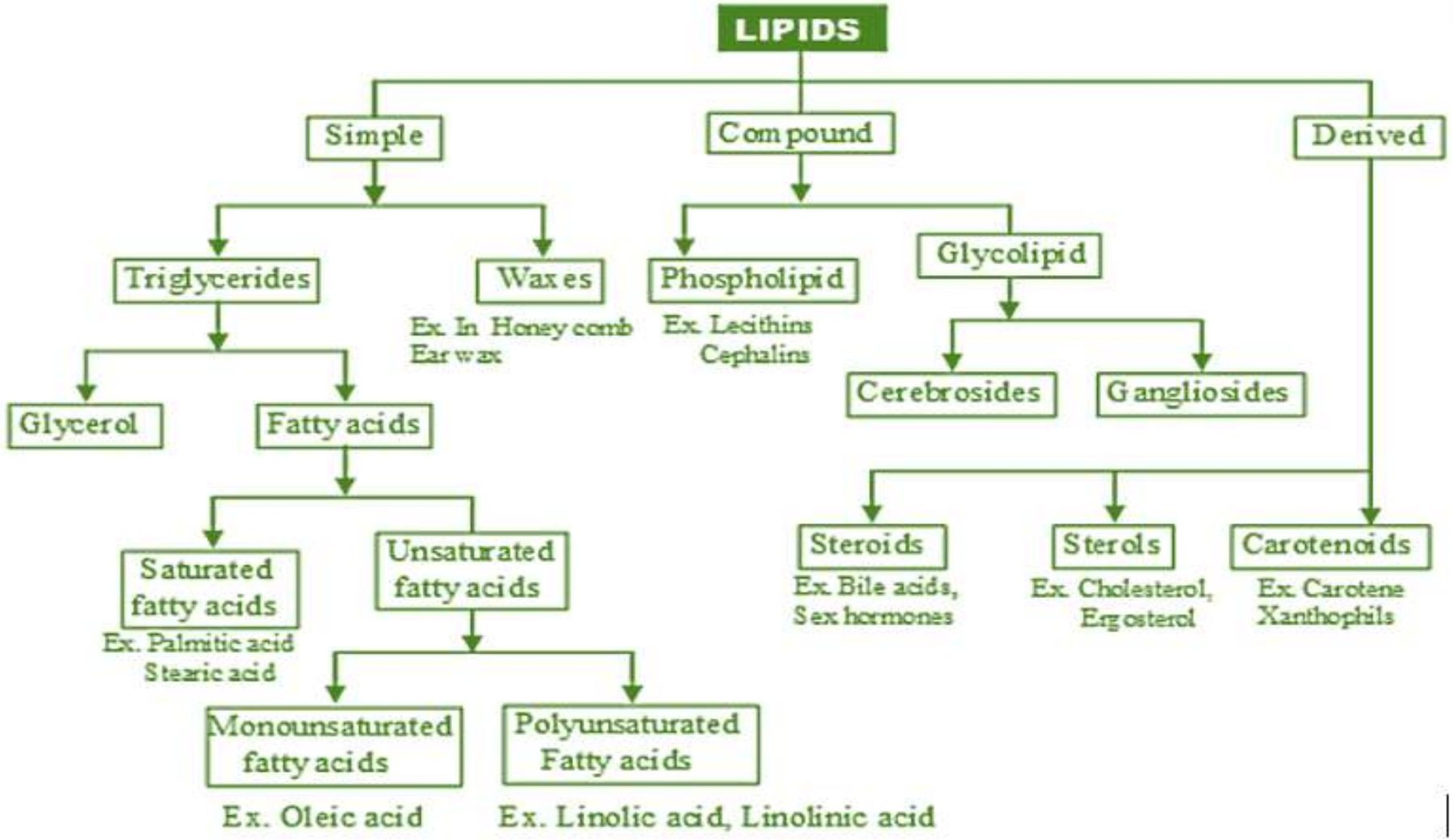


Function

- They act as energy **storage**.
- Lipids play a very important role in the building up of biological **cell membranes.**
- It acts as **insulation**, a poor conductor of heat.
- Protecting the plant leaves from direct heat, and drying.
- They also act as **hormones** in the body.
- It acts as the structural component of the body and also acts as the hydrophobic barrier.
- A major source of energy in animals.
- It provides color to many fruits and vegetables with the presence of carotenoid pigment.

Classification of Lipids



Types of Lipids

- Lipids are mainly classified into three types. They are simple, complex, and derived lipids.
- **Simple Lipids**: Simple lipids are triglycerides, esters of fatty acids, and wax esters. The hydrolysis of these lipids gives glycerol and fatty acids.
- **Complex Lipids:** Complex or compound lipids are the esters of fatty acids with groups along with alcohol and fatty acids. Examples are Phospholipids, Glycolipids.
- **Derived lipids:** Derived lipids are the hydrolyzed compounds of simple and complex lipids. Examples are fatty acids, steroids, fatty aldehydes, ketone bodies, lipid-soluble vitamins, and hormones.

Simple Lipids

- Simple lipids are triglycerides, esters of fatty acids, and wax esters. The hydrolysis of these lipids gives glycerol and fatty acids.
- Classified into
- **Triglycerides**
- Triglycerides are the lipid molecules that are esters formed from one glycerol molecule associated with three fatty acid molecules. They are the constituents of fats and oils. Lipids that is solid at room temperature are fats and lipids that are liquid at room temperature are oils.
- **Glycerol**
- It is a colorless, odorless, viscous liquid that is sweet-tasting and non-toxic. The glycerol backbone is found in those lipids known as glycerides. It is a simple polyol compound.

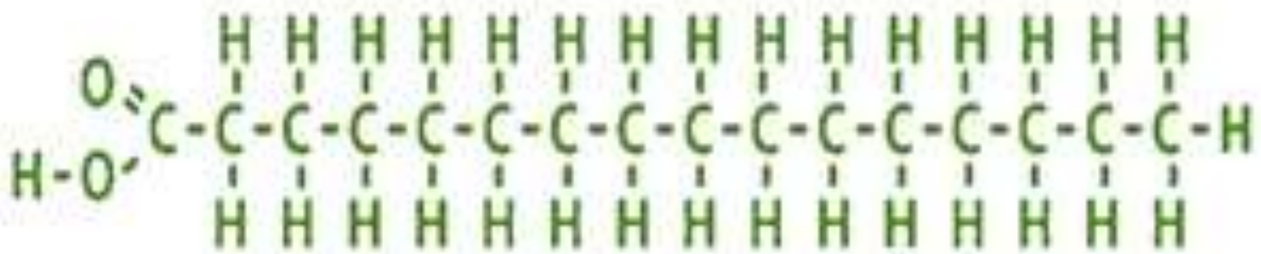
Fatty Acids

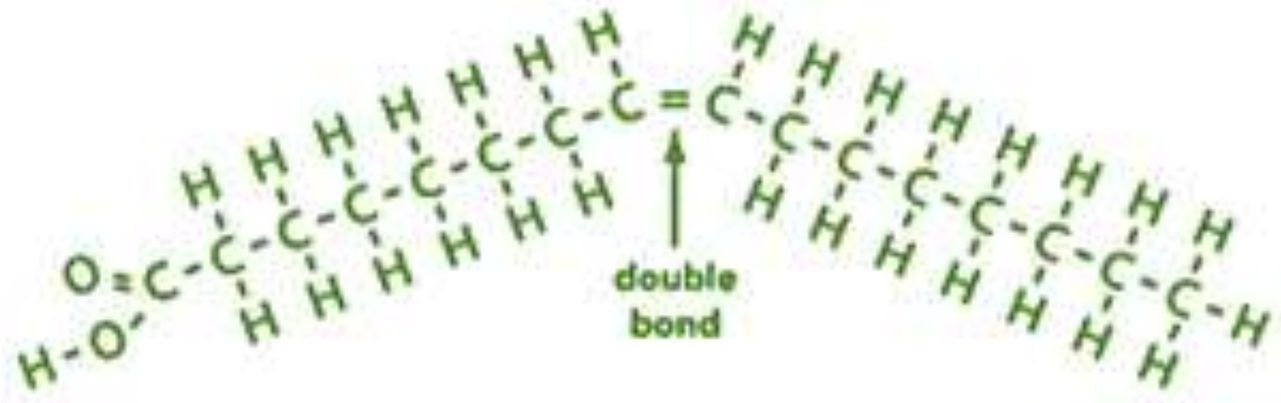
- Fatty acids are carboxylic acids; they are long chains of hydrocarbons with a carboxylic group at the end.
- Fatty acids are an important component of lipids, they are the building blocks of fat in the body.
- There are two types of fatty acids, saturated fatty acids, and unsaturated fatty acids.

- **Saturated fatty acids**

- It consists of single C-C single bonds.
- These molecules fit closely together in a regular pattern and strong attractions between fatty acid chains.
- These fatty acids have high melting points, which makes them solid at room temperature.
- Examples of saturated fatty acids are palmitic acid and stearic acid.

- **Unsaturated fatty acids**
- Unsaturated fatty acids are the fatty acids that consist of one or more C=C double bonds. An unsaturated fatty acid is divided into two types.
- Mono polyunsaturated fatty acids. Example: oleic acid.
- Polyunsaturated fatty acids. Example: linoleic acid.





- **Essential Fatty Acids:** Fatty acids that cannot be produced or synthesized in our bodies are called essential fatty acids.
- These fatty acids need to be taken through a diet to fulfil the body's requirement for different metabolic functions.
- It includes linoleic acid, linolenic acid, and arachidonic acid.
- **Non-essential Fatty Acids:** Non-essential fatty acids include those lipids that are synthesized by our body.
- They are not needed to be taken through any outside food source.
- It includes palmitic acid, oleic acid, and butyric acid.

Role of Fats

- Fats play an essential role in the body including:
- Fats help our body by absorbing and transporting important fat-soluble vitamins.
- They are an important source of essential fatty acids.
- They insulate and protect our vital body organs.
- Fats produce energy in the form of carbohydrates.
- Fats are the structural component of cells.
- They help the body produce and regulate hormones.
- Fats support cell growth.
- They maintain your core temperature.
- Maintains blood pressure and cholesterol under control.

Waxes

- Waxes are usually saturated with long chain monohydric alcohols. They are the simple esters of fatty acids. Here are some of the examples:
- Beeswax: Beeswax includes fatty acids and some free alcohol.
- Carnauba wax: It is a hard wax used on cars and boats.
- Spermaceti: it consists of cetyl palmitate. Used for pharmaceuticals.

Complex Lipids

- Complex or compound lipids are the esters of fatty acids with groups along with alcohol and fatty acids. Examples are Phospholipids, Glycolipids.
- **Phospholipids**
- Phospholipids are constituents of cellular membranes.
- An ester is formed when a hydroxyl reacts with a carboxylic acid and losses H2O.
- Phospholipids are also known as phosphatides, are classes of lipids whose molecule has a hydrophilic head and two hydrophobic tails.
- A head containing a phosphate group and tails derived from fatty acids joined by a glycerol molecule. They serve as emulsifiers.

There are two types of phospholipids:

- **Glycerophospholipids**
- Glycerophospholipids are the class of phospholipids containing glycerol as alcohol, two fatty acids, and phosphate.
- It is the most abundant lipid in the cell membrane.
- **Sphingophospholipids**
- Sphingophospholipids are the class of phospholipids containing sphingosine as alcohol.
- It produces ceramide by an amide linkage to a fatty acid. Ceramide is an important component of skin.
- It acts as a second messenger to regulate **programmed cell death**.

- **Glycolipid**
- It is a structural lipid, an essential part of the cell membrane.
- They are lipids with a carbohydrate, attached by a glycosidic bond.
- They act as receptors at the surface of the red blood cell.
- It helps in the determination of an individual blood group.
- It has an important role in maintaining of stability of the cell membrane.
- It kills the pathogens to help the immune system of the body.
- Cerebrosides and Gangliosides are the two types of Glycolipids.

Derived Lipids

- Derived lipids are the hydrolyzed compounds of simple and complex lipids. Examples are fatty acids, steroids, fatty aldehydes, ketone bodies, lipid-soluble vitamins, and hormones.
- **Steroids**
- Steroids are found in the cell membrane and have fused ring structures. Many steroids have -OH functional groups, they are also hydrophobic and insoluble in water. All the steroids have 4 linked carbon rings and most of them have a short tail. Steroids also act as hormones in the body.

- **Sterols**
- Sterols are the solid steroid alcohols that are widely present in plants and animals such as cholesterol and ergosterol.
- They are the subgroup of steroids, which naturally occur in most eukaryotes. They are found in animal products.
- They are used to make bile for digestion in the body.
- Sterols can have greater than half of the membrane lipid content in cells and they are known to alter membrane structure and fluidity.

- **Carotenoids**
- Carotenoids are lipid-soluble compounds.
- They are pigments that are mainly responsible for many of the yellow and red colors of plant and animal products.
- Carotenoids consist of carotenes and xanthophylls.
- A class of hydrocarbons is carotenes and its oxygenated derivatives are xanthophylls.
- They give the color to many fruits and vegetables.
- They have antioxidant and anti-inflammatory properties for humans.
- Carotenoids are important in the health of the human eye.

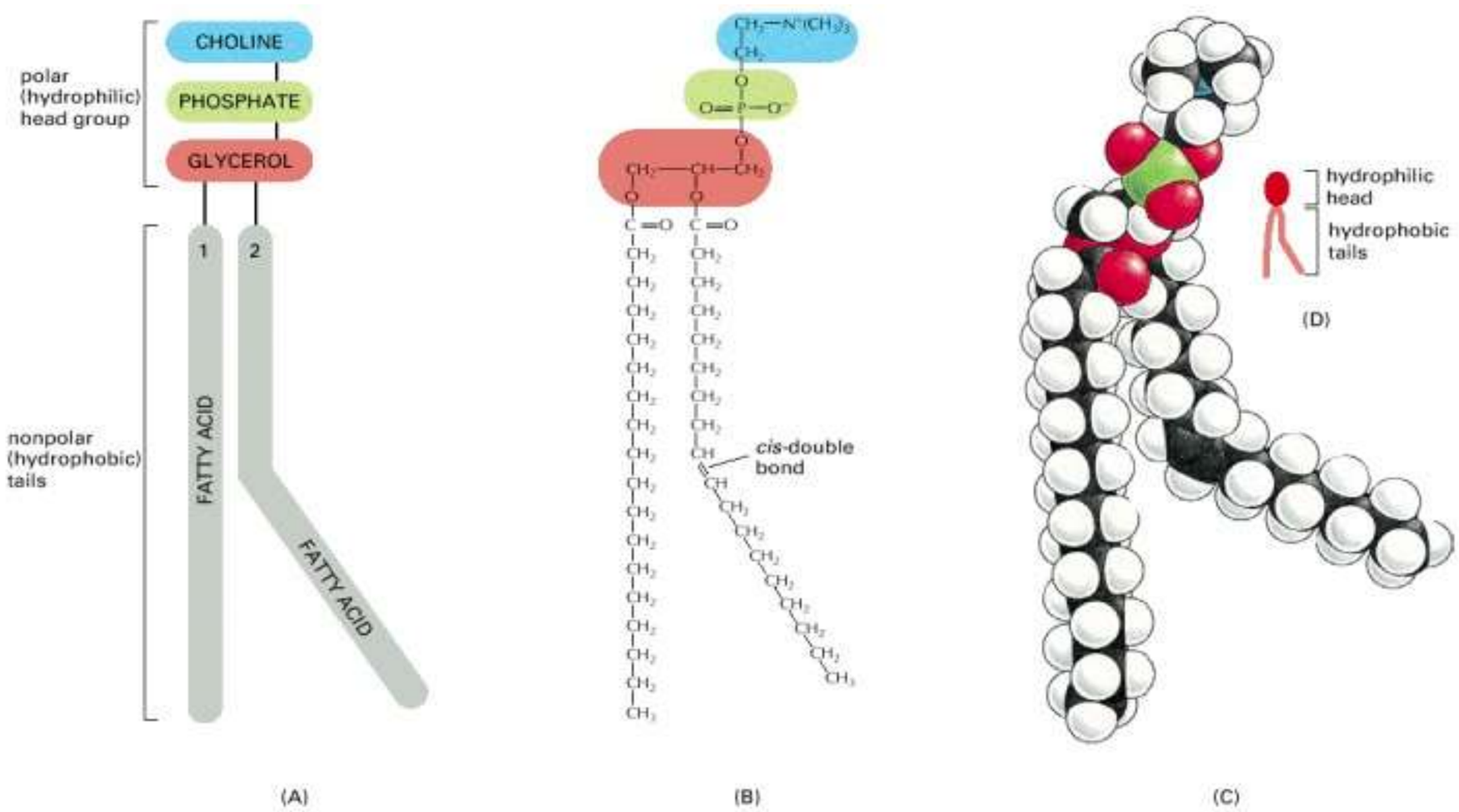
LIPOPROTEINS

- Cholesterol and triglycerides are the major lipids in humans and are transported in plasma by lipoproteins.
- A lipoprotein is composed of cholesterol, triglycerides, and a single apolipoprotein B_{100} molecule (apoB) when secreted into plasma by the liver, and is referred to as a *very low-density lipoprotein* (*VLDL*).
- The triglycerides are rapidly removed by the enzyme lipoprotein lipase and used for energy consumption and storage.

- As triglycerides are being progressively removed, the lipoprotein is referred to as a *VLDL remnant particle*.
- After most of the triglycerides have been removed, the lipoprotein becomes denser and is referred to as a *low-density lipoprotein* (*LDL*).
- However, it is important to recognize that a VLDL particle, a remnant particle, and an LDL particle are merely different names for the same circulating apoB lipoprotein at different stages in its lifecycle, depending on the lipid content that it carries.

PHOSPHOLIPIDS

- All of the lipid molecules in cell membranes are amphipathic (or amphiphilic)—that is, they have a hydrophilic ("water-loving") or *polar* end and a hydrophobic ("water-fearing") or *nonpolar* end.
- The most abundant membrane lipids are the phospholipids.
- These have a polar head group and two hydrophobic *hydrocarbon tails.*
- The tails are usually fatty acids, and they can differ in length (they normally contain between 14 and 24 carbon atoms).
- One tail usually has one or more *cis*-double bonds (i.e., it is *unsaturated*), while the other tail does not (i.e., it is *saturated*).



As shown in Figure, each double bond creates a small kink in the tail. Differences in the length and saturation of the fatty acid tails are important because they influence the ability of phospholipid molecules to pack against one another

CHOLESTEROL

- Cholesterol is one of several types of fats (lipids) that play an important role in your body.
- Cholesterol is a waxy substance found in all cells of body.
- The body needs it to make hormones, Vitamin D, and substances that aid in digestion. The liver makes all the cholesterol needed for these functions.
- For the fat-like cholesterol to travel in the bloodstream, the cholesterol is packaged in molecules called lipoproteins.
- These small packages are made of fat (lipid) on the inside and proteins on the outside. Two of the lipoproteins that carry cholesterol throughout the body are LDL and HDL.
- It is important to have healthy levels of both LDL and HDL.

LDL Cholesterol

- Low-density lipoprotein or LDL is the bad cholesterol.
- LDL is the main constituent in the fatty deposits that can develop in the arteries.
- Elevated LDL increases the risk of heart disease, stroke, aortic aneurysm, and arteriosclerosis in other arteries of the body.
- An optimal LDL level is 100 or less; 100 to 129 is near optimal for most people.
- A more aggressive target of LDL <70 is often used for these patients with coronary artery disease, carotid or peripheral arterial disease, aortic aneurysm, diabetes,
- Dietary changes can reduce LDL levels an average of 15 percent.
- Dietary changes have the most effect when initial triglyceride levels are elevated.

HDL Cholesterol

- High-density lipoprotein (HDL), or good cholesterol, protects the arteries against the formation of fatty deposits.
- The HDL helps remove unused cholesterol from the body. Heredity plays an important role in determining your HDL level.
- A low HDL level is an independent risk factor for heart disease.
- HDL is slightly raise by losing excess weight, exercising routinely, and not smoking.
- If heart disease develops in an individual with optimal LDL but low HDL a medication may be added to target the HDL.
- Low HDL is a value of 40 or below in men and 50 or below in women.
- High HDL (greater than 60) is considered protective.

Functions

Lipids can serve a diverse range of functions within a cell, including:

- **Storage of energy** for long-term use (e.g. triglycerides)
- **Hormonal roles** (e.g. steroids such as oestrogen and testosterone)
- **Insulation** – both thermal (triglycerides) and electrical (sphingolipids)
- **Protection** of internal organs (e.g. triglycerides and waxes)
- **Structural components** of cells (e.g. phospholipids and cholesterol)

THANK YOU