



AL-MUSTAQBAL UNIVERSITY COLLEGE

Department of Biomedical Engineering

Biochemistry

(Lipids and their function and fatty acids)



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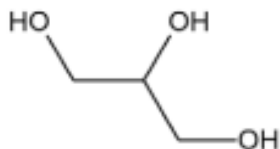
Lipid.

is the collective name for fats, oils, waxes and fat-like molecules (such as steroids) found in the body. The basic unit of lipids is a triglyceride, synthesised from glycerol (propane-1,2,3-triol) and fatty acids. Glycerol is a type of alcohol. Alcohols are organic compounds. Their molecules are characterized by hydroxyl groups, -OH. Glycerol is a trihydric alcohol, which means each molecule has three hydroxyl groups.

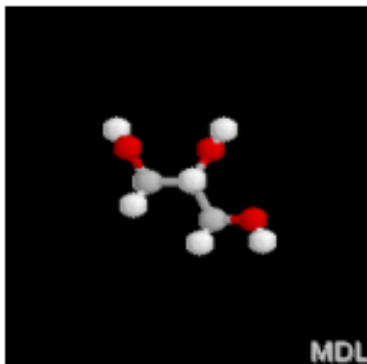
Glycerol, C₃H₈O₃

Glycerol is a trihydric alcohol, in other words each molecule has three hydroxyl groups

Its skeletal formula is



There is one hydroxyl (alcohol) group attached to each carbon atom in the chain



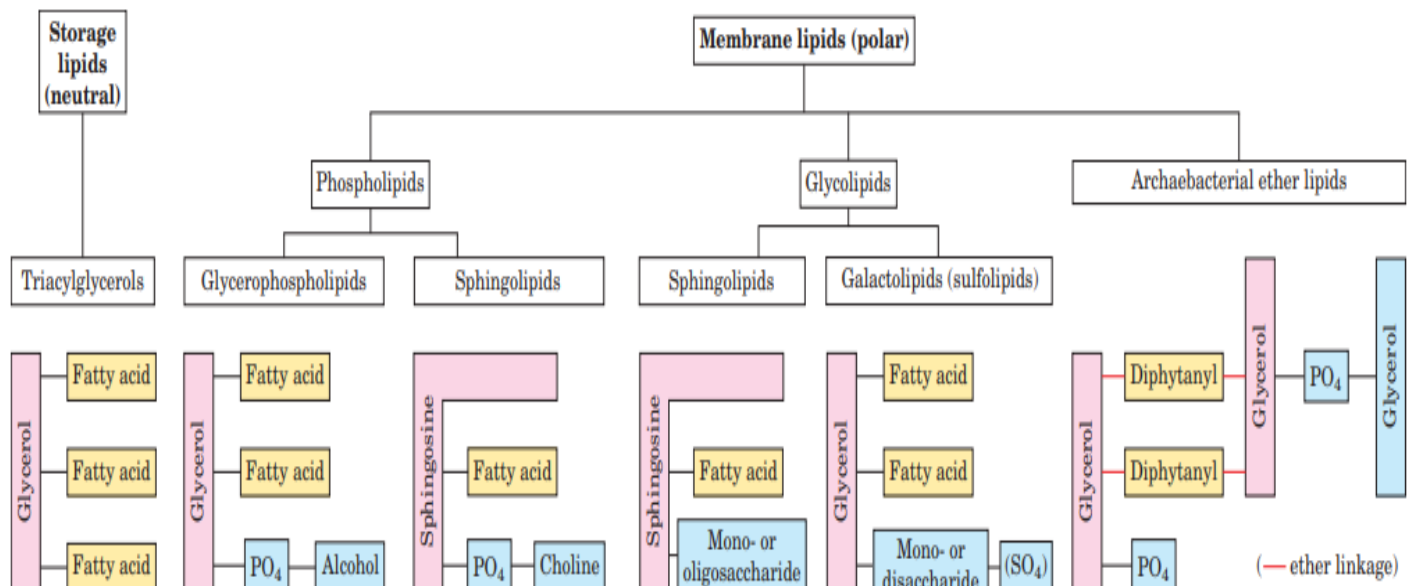
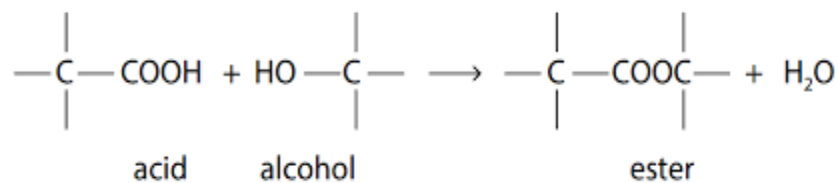
Glycerol

Where do Lipids Come From?

Excess carbohydrates in the diet are converted into triglycerides, which involves the synthesis of fatty acids from acetyl-CoA in a process known as lipogenesis, and takes place in the endoplasmic reticulum. In animals and fungi, a single multi-functional protein handles most of these processes, while bacteria utilize multiple separate enzymes. Some types of unsaturated fatty acids cannot be synthesized in mammalian cells, and so must be consumed as part of the diet, such as omega-3.

Hydrolysable and Non-hydrolysable Lipids?

Lipids that contain an ester functional group are hydrolysable in water. These include neutral fats, waxes, phospholipids, and glycolipids. Non-hydrolyzable lipids lack such functional groups and include steroids and fat-soluble vitamins (A, D, E, and K).



Fatty acids

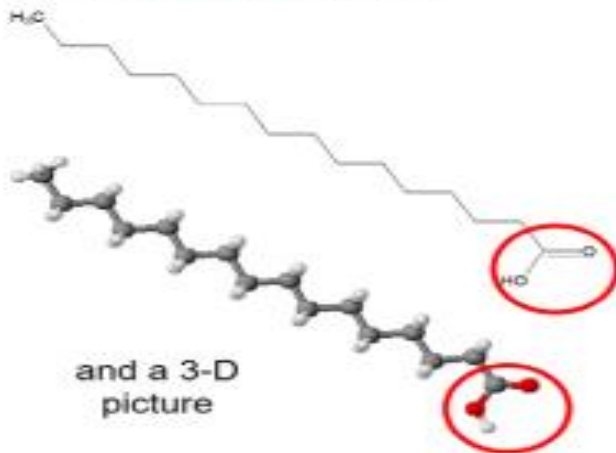
Fatty acids are also organic compounds. Each fatty acid has a carboxylic acid (-COOH) group. Some fatty acids are saturated. This means all carbon-carbon bonds are single covalent bonds. Other fatty acids are unsaturated. This means that while most carbon-carbon bonds are single covalent bonds, some are double bonds.

Fatty acids

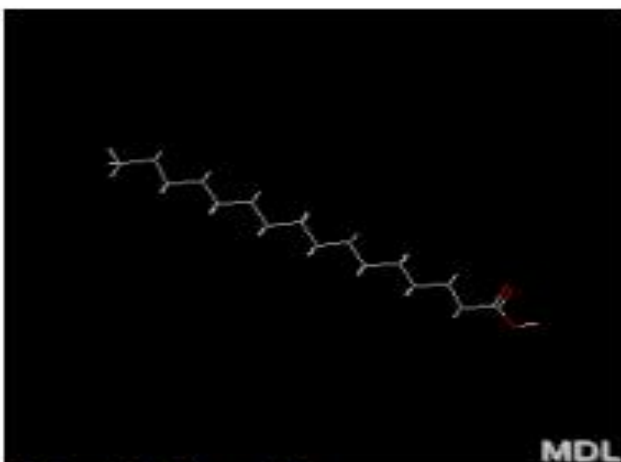
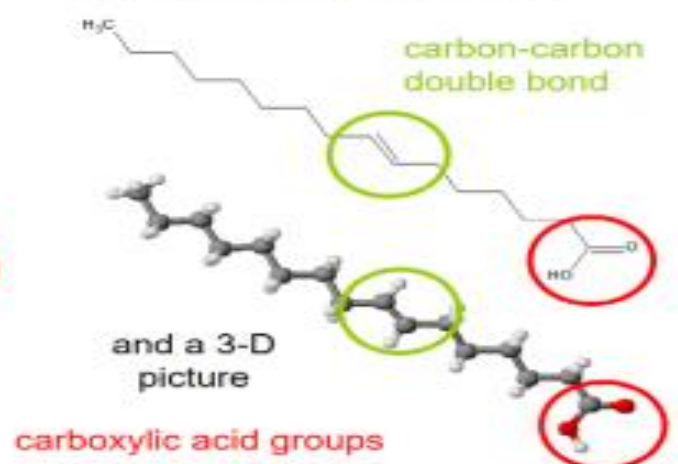
Fatty acids are carboxylic acids with a long hydrocarbon tail

They may be **saturated** or **unsaturated**

Here is the skeletal formula for a typical **saturated** fatty acid

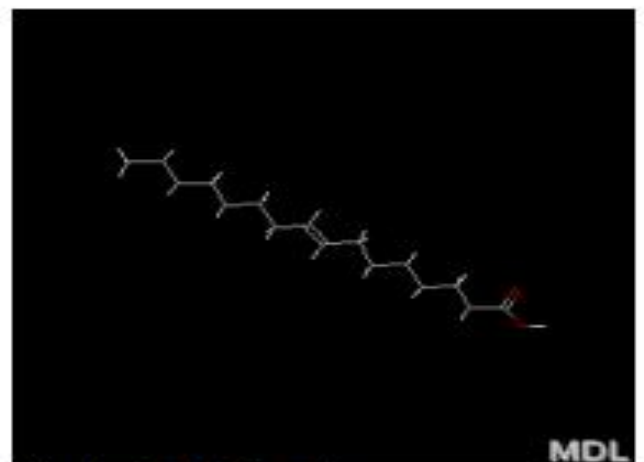


Here is the skeletal formula for a typical **unsaturated** fatty acid



Saturated fatty acid

MDL



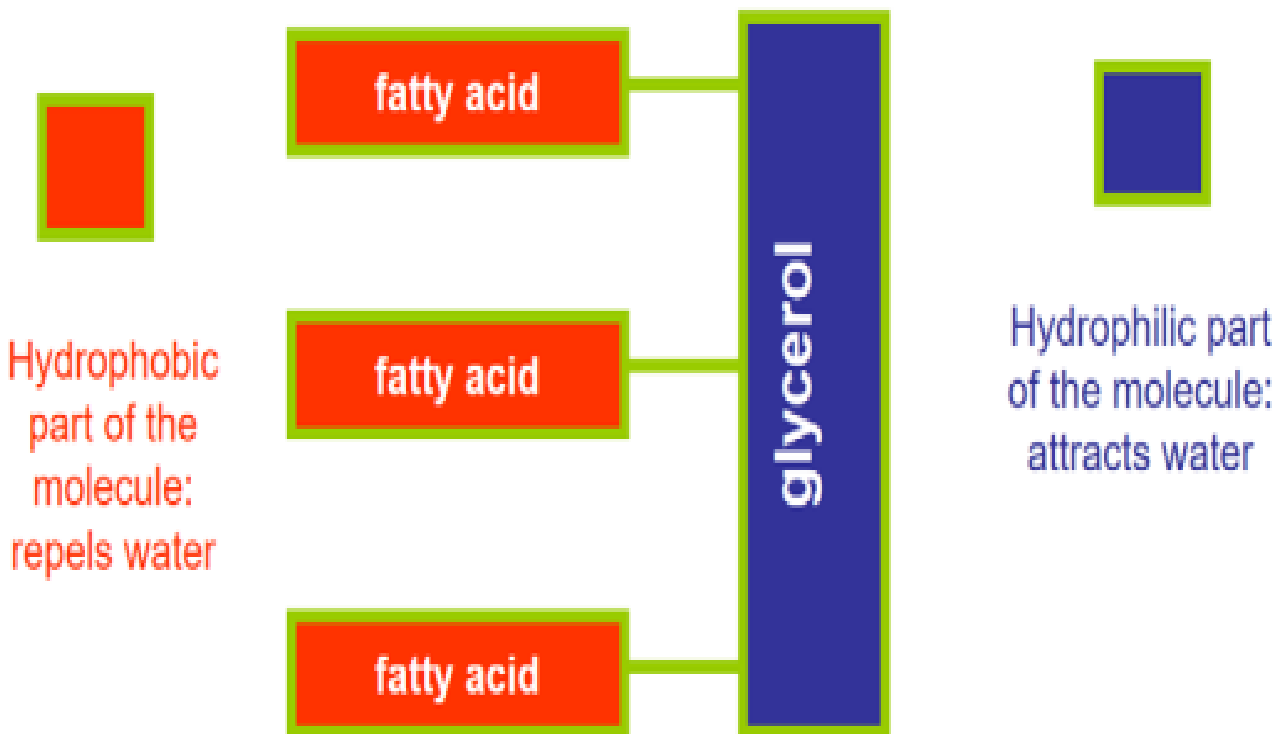
Unsaturated fatty acid

MDL

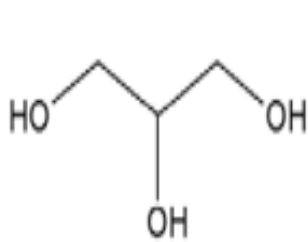
Esters.

Alcohols react with carboxylic acids to form esters $R_1OH + R_2COOH \rightarrow R_2COOR_1 + H_2O$. As with the formation of glycosidic and peptide bonds, this is a condensation reaction. A water molecule splits out. The glycerol molecule has three hydroxyl groups. When one reacts with a fatty acid a monoglyceride forms. When two react with two fatty acid molecules a diglyceride forms. And when three react with three fatty acid molecules a triglyceride forms.

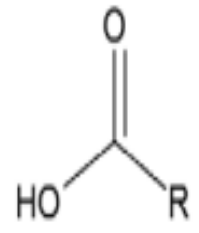
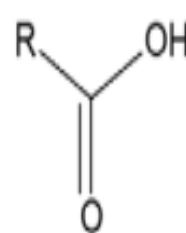
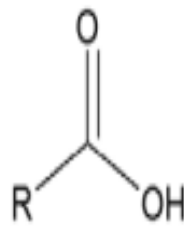
Representation of a triglyceride



Formation of a triglyceride

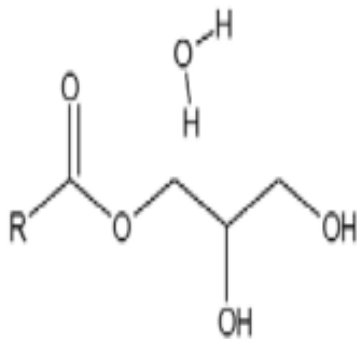


glycerol



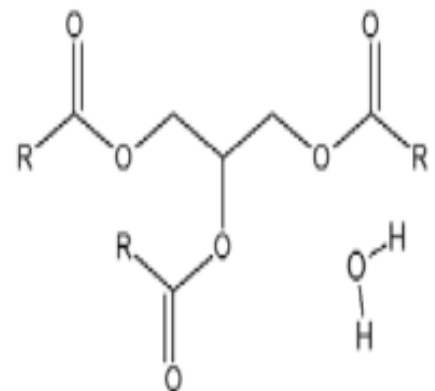
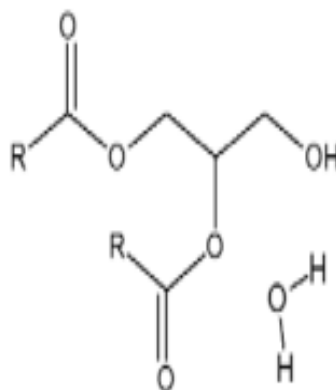
fatty acids (R is shorthand for the hydrocarbon tail)

Each **fatty acid** reacts with a **hydroxyl** groups to form an **ester** group and a water molecule



monoglyceride

diglyceride

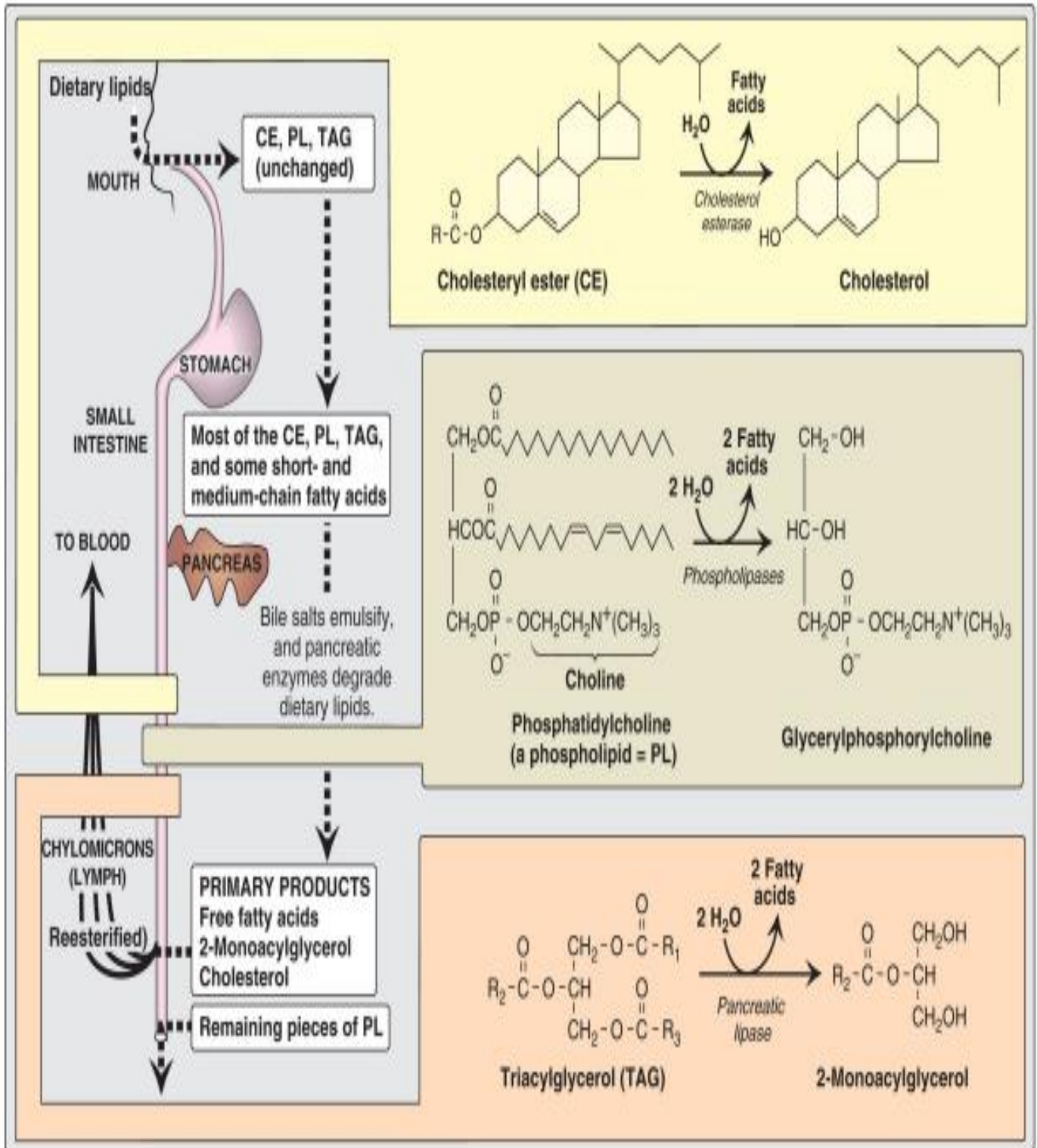


triglyceride



Triglycerides formed between glycerol and unsaturated fatty acids are usually oils. Those formed with saturated acids are usually fats.

Overview of lipid digestion.



Functions of Lipids.

1. Storage form of energy (triglycerides)
2. Structural components of bio membranes (phospholipids and cholesterol)
3. Metabolic regulators (steroid hormones and prostaglandins)
4. Act as surfactants, detergents, and emulsifying agents (amphipathic lipids)
5. Act as electric insulators in neurons
6. Provide insulation against changes in external temperature (subcutaneous fat)
7. Give shape and contour to the body
8. Protect internal organs by providing a cushioning effect (pads of fat)
9. Help in absorption of fat-soluble vitamins (A, D, E and K)