AL-Mustaqbal University College

Medical laboratory Techniques Department

Clinical Biochemistry

Lecture (6)
(Classification and Digestion Of Lipids)

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A lipid is an organic substance found in living systems that is insoluble in water but is soluble in organic solvents.

Lipids vary widely in their structures. They have mostly C,H and some have a few polar atoms/ functional groups.

The importance of fats to the human body?

- Fats are a concentrated source of energy, and provide the body with higher calories than those obtained from the combustion of carbohydrates and proteins.
- Provides the body with essential fatty acids for the human body.
- Essential for proteins that make vitamin A, it is the main component of cell membranes and important body organs.
- Helps to benefit more from food because it helps the stomach and intestines to last longer.
- Maintains body temperature

Lipids include:

1- fats and **oils** 2- **steroids** 3-**waxes**

Fats & oils make up 95% of the nutritional lipids, the other 5% are steroids. Waxes are functional only. **Fats** are solid triglycerides **Oils** are liquid triglycerides .

Fats and oils are energy rich , it can storage in plants and animals and structural component like cell membrans. Lipid can be grouped into two main classes:

*Saponifiable lipids.

*NonSaponifiable lipids.

Saponification: the process in which esters are hydrolyzed under basic conditions (NaOH,KOH).

1-Saponifiable lipids like:

* Triglycerides. * Waxes. * Phospholipids. * Sphingolipids .

2-Nonsaponifiable lipids: are not esters and can not hydrolyzed like:

*Isoprenoids. *Steroids. *Prostaglandines.

Saponifiable lipids can be classefied also into:

*Simple lipids (fatty acid+ alcohol) and includes waxes and triglyceride.

*Complex lipids (fatty acid + alcohol + other compounds) and includes phosphoglycerides and sphingolipids.

Fatty acids : The fundamental building blocks of many lipids and are long chain carboxylic acid. The long nonpolar tail of F.A.that are responsible for most of the fatty or oily characteristics of fats.

Energy

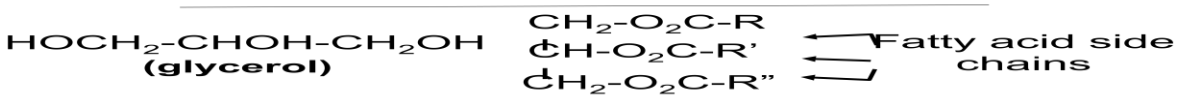
Fats are an important source of calories.

Typically 30-40% of calories in American diet are from fat.

Fat is the major form of energy storage. Typical body fuel reserves are: 1- fat: 100,000 kcal. 2- protein: 25,000 kcal. 3- carbohydrate: 650 kcal.

Provides 60% of energy needs for body at rest TAG reserves would enable someone to survive starvation for ~30 days.

Fats and Oils
The Triglycerides We Eat



Triglycerides/fatty acids are characterized/named by:

1) The length/number of carbons in the side chains

2) The number of carbon-carbon double bonds in the side chains (the degree of unsaturation).

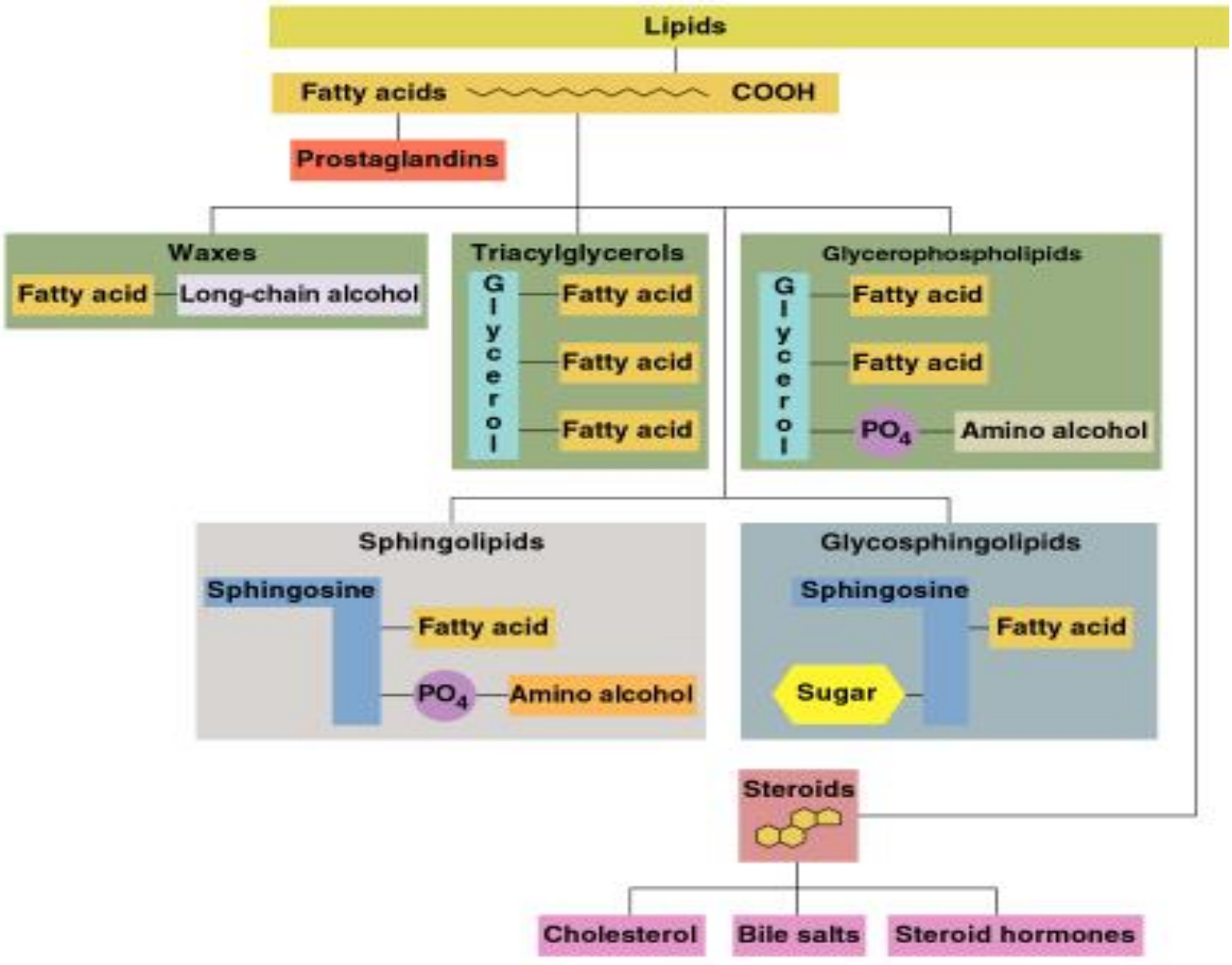


Figure1:-Classification of lipids

Fatty Acids

Lipids are non-polar (hydrophobic) compounds, soluble in organic solvents.

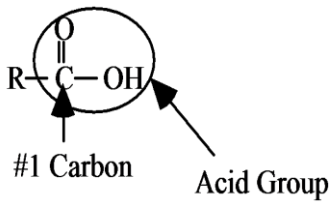
Most membrane lipids are **amphipathic**, having a **non-polar** end and a **polar** end.

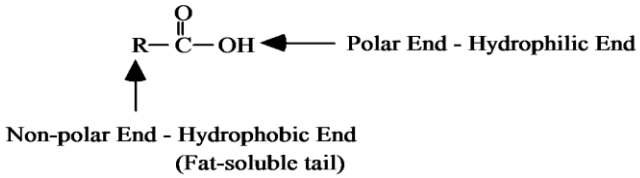
Fatty acids consist of a hydrocarbon chain with a carboxylic acid at one end.

A 16-C fatty acid: $CH_3(CH_2)_{14}COO^-$

Non-polar polar

A 16-C fatty acid with one cis double bond between C atoms 9-10 may be represented as **16:1 cis Δ^9**.

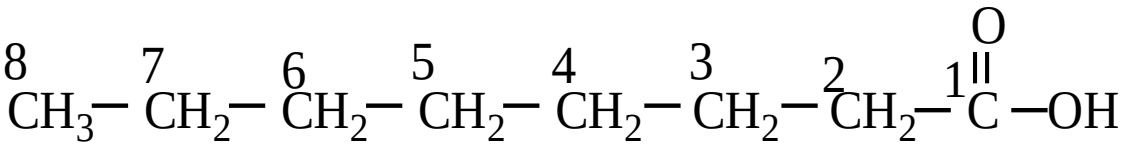




Fatty acids

- Are long-chain carboxylic acids.
- Typically contain 12-18 carbon atoms.
- Are insoluble in water.
- Can be saturated or unsaturated.

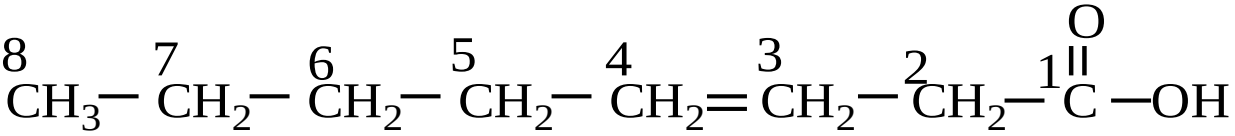
Saturated Fatty Acids



Saturated fatty acids have

- Single C–C bonds.
- Molecules that fit closely together in a regular pattern.
- Strong attractions between fatty acid chains.
- High melting points that make them solids at room temperature.

Unsaturated Fatty Acids



Unsaturated fatty acids

- Have one or more double C=C bond
- Typically contain *cis* double bonds.
- Have “kinks” in the fatty acid chains.
- Do not pack closely.
- Have few attractions between chains.
- Have low melting points.
- Are liquids at room temperature.

Omega-6 and Omega 3- Fatty Acids

Fatty acids

- In vegetable oils are mostly omega-6 with

the first C=C at C6.

linoleic acid

$CH_3–(CH_2)_4–CH=CH–CH_2–CH=CH–(CH_2)_7–COOH$

6

- In fish oils are mostly omega-3 with the

first C=C at C3.

linolenic acid

$CH_3–CH_2–(CH=CH–CH_2)_3–(CH_2)_6–COOH$

3

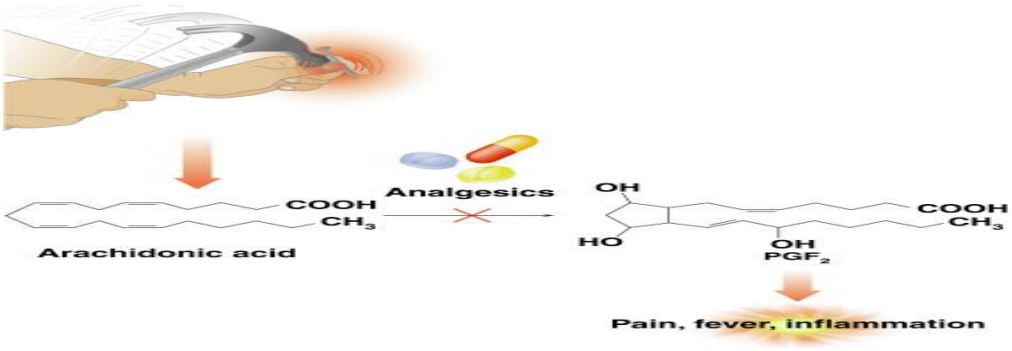
Prostaglandin: One of a number of hormone-like substances that participate in a wide range of body functions such as the contraction and relaxation of smooth muscle, the dilation and constriction of blood vessels, control of blood pressure, and modulation of inflammation. Prostaglandins are derived from a chemical called arachidonic acid

Prostaglandins have

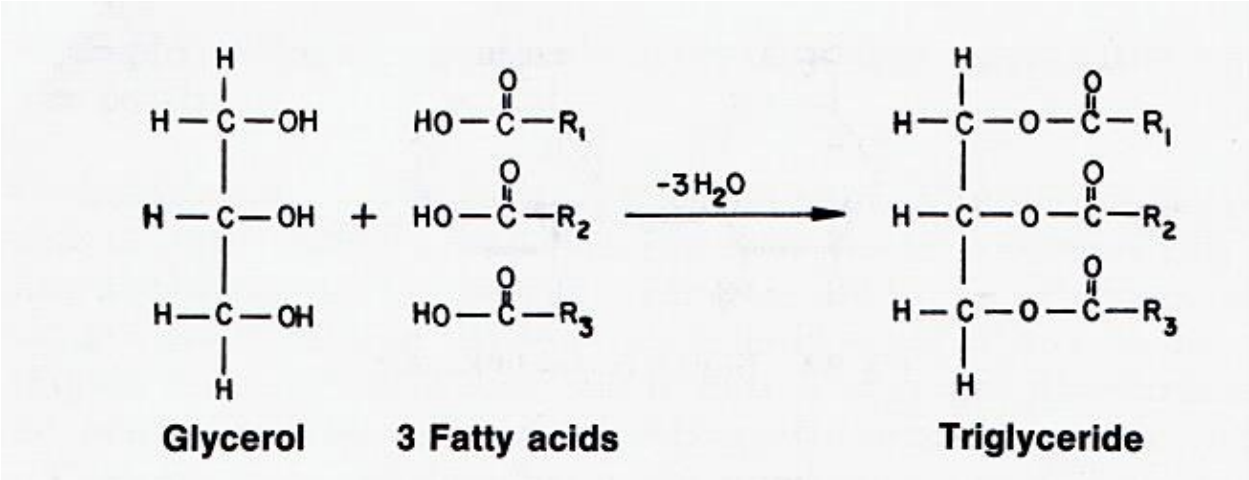
- 20 carbon atoms in their fatty acid chains.
- An OH on carbon 11 and 15.
- A trans double bond at carbon 13.

Prostaglandins in the Body?

Prostaglandins are Produced by injured tissues. Involved in pain, fever, and inflammation. Not produced when anti-inflammatory drugs such as aspirin inhibit their synthesis.



Fats and oils are Also called triacylglycerols:-

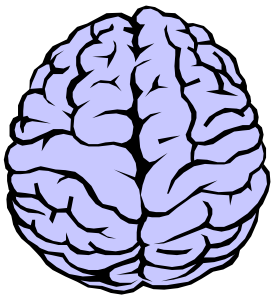


Cholesterol

- Cholesterol, an important constituent of cell membranes, has a rigid ring system and a short branched hydrocarbon tail.
- Is the most abundant steroid in the body.
- Has methyl CH_3- groups, alkyl chain, and -OH attached to the steroid nucleus.

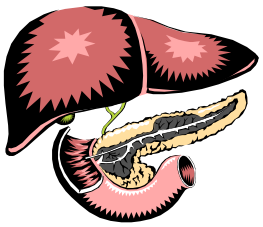
Cholesterol in the Body?

- Cellular membranes
- Myelin sheath, brain, and nerve tissue
- Bile salts
- Hormones
- Vitamin D
- Is obtained from meats, milk, and eggs.
- Is synthesized in the liver.
- Clogs arteries when high levels form plaque.



Bile Salts

- **Is a yellowish-brown or green synthesized in the liver from cholesterol.**
- **Stored in the gallbladder**
- **Secreted into small intestine**
- **Mix with fats to break them part**
- **Emsulsify fat particles**



Lipoproteins?

- Combine lipids with proteins and phospholipids.
- Are soluble in water because the surface consists of polar lipids.

Usually; saturated fat in diet cause high blood cholesterol level and these consider risk factor of coronary heart diseases.

Types of Lipoproteins?

- There are five different types of lipoproteins in the blood, Differ in density, composition, and function.Include :-

1- Very Low-Density Lipoproteins (VLDL)

These lipoproteins consist of mainly triglycerides, some cholesterol molecules, and less protein.1 The more fat a lipoprotein contains, the less density it has. In this case, VLDL is less dense than most lipoproteins because of its high lipid composition.

VLDL is made in the liver and is responsible for delivering triglycerides to cells in the body, which is needed for cellular processes. As triglycerides get delivered to cells, VLDL is made up less of fat and more of protein, leaving cholesterol on the molecule. As this process occurs, VLDL will eventually become an LDL molecule.

2- Low-Density Lipoproteins (LDL)

LDL consists of more cholesterol than triglycerides and protein. Because it contains less lipid and more protein in comparison to VLDL, its density is greater. LDL is responsible for carrying cholesterol to cells that need it.

3-High-Density Lipoprotein (HDL)

Compared to LDL, HDL consists of less cholesterol and more protein, making these lipoproteins the densest. HDL is made in the liver and in the intestines. It is responsible for carrying cholesterol from cells back to the liver. Because of this, HDL is also considered the “good” cholesterol.

4-Chylomicrons

Are the least dense out of all of the lipoproteins. These molecules are primarily made up of triglycerides and a small amount of protein. Chylomicrons are responsible for transporting lipids from the intestinal tract to cells in the body.

5-Intermediate density lipoproteins (IDL)

Are less dense than LDL molecules but denser than VLDL particles. As the triglycerides on VLDL are broken down by the cells that need it, the particle becomes denser due to the change in the lipid to protein ratio.

Where is fat digested and absorbed?

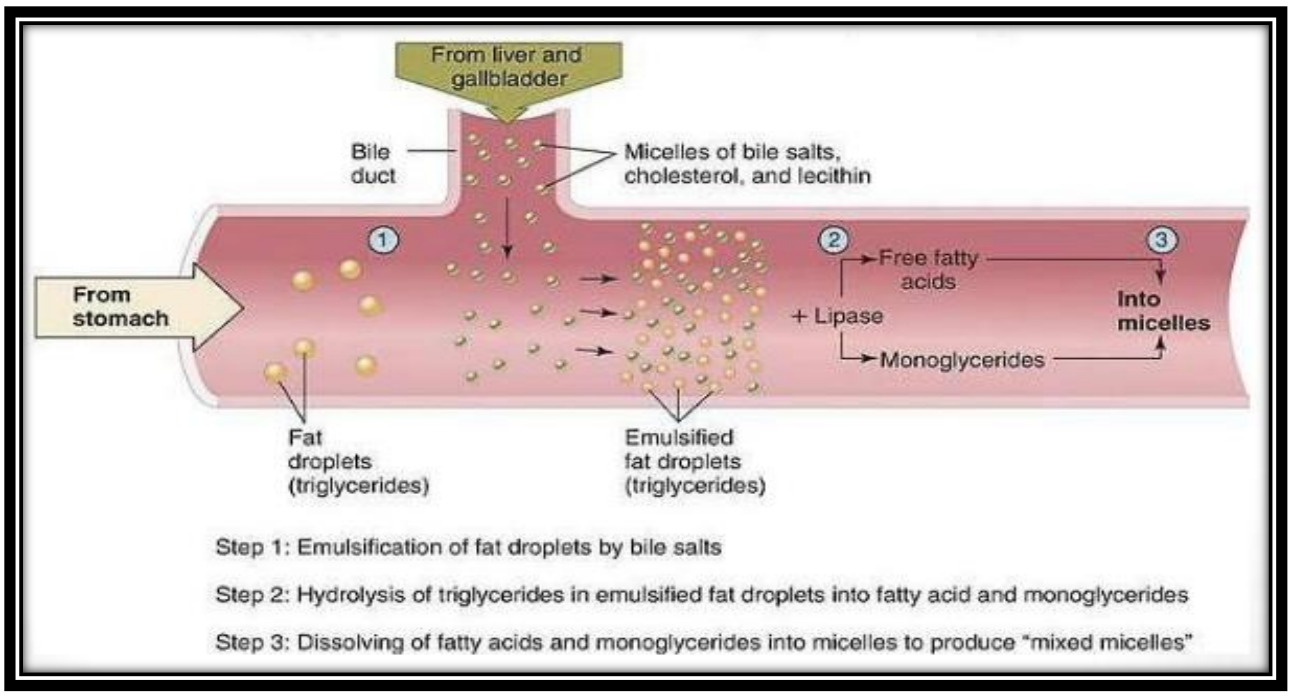
No part of the fat is digested in the mouth, and in the stomach a small amount of fat that is formed is digested in the stomach. An emulsifier such as egg yolk and butter, and the digestion of fats occurs in the small intestine by steps next:-

1-The bile is excreted from the gallbladder which serves to convert the fats into a fatty emulsion to facilitate The work of digestive juices

2- The pancreas and small intestine secrete enzymes that break down and digest fats into their components to the basic.

3-Fats are absorbed by the intestinal wall and distributed to various body systems.

4-The fats travel to the liver, which works to convert them into compounds suitable for cell consumption.



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References

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