



University of Jordan
Faculty of Medicine



Medical Committee
The University of Jordan

Introduction to

BIOCHEMISTRY

Lecture #: (.....5.....)



Sheet



Slides



Other

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Price:

Sheet 5 .. Lipids (Dr. Nafith) :

Classification of fatty acids :

- they are classified depending on the existence of double bonds to :

1) Saturated fatty acids : All bonds are SINGLE and no double bonds .

2) Unsaturated fatty acids : they contain one or more double bonds .

* The unsaturated fatty acids can be classified depending on the number of the double bonds they contain into :

a. Monounsaturated fatty acids : contain only one double bond .

b. Polyunsaturated fatty acids : contain more than one double bond .

Saturated Fatty acids :

1. Solid at room temperature .

2. Most of the fatty acid contains even number of carbon atoms

note : in amino acids the number is odd ..

- the hydrocarbon chain is classified into :

a) short chain : (1-6) carbons .

b) medium chain : (7-10) carbons .

c) long chain : (more than 10) .

** Short chain :

1. Liquid in nature .

2. Water soluble . (because the hydrocarbon part is short >> hydrophobic part is short)

3. Volatile at room temperature .

Examples : Acetic acid (2 carbons) , Butyric (4 carbons) , Caproic (6 carbons) .

** Medium chain:

1. Solid in nature .

2. Water soluble (because the hydrocarbon part is short >> hydrophobic part is short)

3. Non volatile at room temperature .

Example : Caprylic , Capric .

** Long chain :

1. Solid in nature .

2. Water in soluble (because the hydrocarbon chain is long so the hydrophobic part is long)

3. Non volatile at room temperature.

Examples : Palmitic (16) , Stearic(18) , Lignoceric.

++ Note : the Doctor said that he isn't expecting us to memorize the structures of molecules BUT he said that we must be able to identify them and know how to link the structure with the function .

For example : we should be able to identify carbohydrates like (cyclic or aliphatic) :

1) Glucose

2) mannose

3) Galactose

4) fructose

but we don't have to draw them .

Any structure with long or short hydrocarbon chain linked to carboxylic is "FATTY ACID".

#Unsaturated fatty acids:

-They contain more than one double bond, and they are naturally "cis"

-they have kinks so they don't pack closely so this affects solubility and melting point.

they are divided as we said before to :

1) Monounsaturated fatty acids : contains only one double bond .

Examples :

a. Palmitoleic acid (derivative of palmitic acid) : 16 carbons and the double bond is on carbon 9 .

b. Oleic acid: 18 carbons and the double bond is on carbon 9 .

c . Nervonic acid : 24 carbons and the double bond is on carbon number 15 .

2) Polyunsaturated fatty acids :

** Essential fatty acids :

→ they can't be synthesized inside the body and must be obtained from food .

there are another subgroup of essential fatty acids that is Conditional " Essential Fatty acids " ; these are the molecules that can't be synthesized unless the PURE essential fatty acids are available , if the PURE essential fatty acids aren't there then the Conditional ones become Essential .

Functions of essential fatty acids:

- They are useful in the treatment of atherosclerosis (transporting blood cholesterol & triglycerides & lowering them)

- Synthesis of certain hormones

- Cellular & subcellular membranes

- Skin integrity, normal growth & reproduction

- Blood clotting (intrinsic factor)

- Important role in health of the retina & vision

- They can be oxidized for energy production

+ Source of poly unsaturated essential fatty acids is either from plants or animals .

- the essential fatty acids are important in treating the atherosclerosis as we mentioned before because they are necessary in producing lipids that are important to produce lipoproteins which carry cholesterol and triglycerides so it prevent atherosclerosis. It prevents residues from forming on the walls of arteries

- and they are also important in vision because they are attached to retinal in rhodopsin and photopsin but they are proteins important in vision.

-they give energy because :

breaking fatty acid will give carbon molecule > then acetyl CoA and then it enters the krebs cycle to produce energy.

Two Important essential fatty acids :

- 1) Linoleic : it has two double bonds .
 - 2) linolenic : it has three double bonds .
- both have 18 carbons ←

- another poly unsaturated fatty acid is :
Arachidonic fatty acid that is conditionally essential and can be produced using linoleic acid .
*it has a function connected to prostaglandins synthesis.

#Naming Fatty Acids :

1. Regular system : we give the most oxygenated carbon that is the carboxylic group number one and the last carbon will be the "CH₃" (CH₃ has the highest number)

2.Omega nomination (system) :
we give the " CH₃ " number one and count from it to reach the first double bond and name the molecule according to it .

-example : Omega 3 means that the double bond is on the carbon number three starting from carbon " CH₃ " as carbon number one .

-- if there is a double bond after carbon number 9 or 10 then it must be essential fatty acid (according to omega system)

*Linoleic acid : omega 6

*Linolenic acid : omega 3

when we say " omega 3 " this means group of fatty acids.

- In omega system if we have polyunsaturated fatty acid we care about the first one ONLY!

Lipids are composed of alcohol and fatty acid, they are either simple or compound (conjugate).

#Simple lipids :

1) Triacylglycerols : { fats and oil}
Glycerol + 3 fatty acids (same or different).

- Esters of glycerol with various F.A (commonest in animal fats are palmitic, stearic & oleic acids) .

- Uncharged due to absence of ionizable groups in it .

- The most abundant lipids in nature

- Either:

- a) Simple (3 identical fatty acids): of the same type, e.g., tripalmitin (3 palmitic acids)

- b) Mixed (3 different fatty acids): of different types, e.g., stearo-diolein & palmito-oleo-stearin

- Natural fats are mixtures of mixed triglycerides with a small amount of simple triglycerides

*Physical properties of fats and oil (Neutral) :

1. Freshly prepared triacylglycerols are colorless, odorless & tasteless (the yellow color is due to carotene pigments)

2. Fats have specific gravity less than 1 (floats on water)

3. Fats are insoluble in water (soluble in organic solvents as ether & benzene)

4. Oils are liquid at room temperature, whereas, fats are solids (unsaturated vs. saturated) .

Most of the fatty acids in a tissue are saturated (melting point is higher) solid at room temperatures. In oils, fatty acids are mostly unsaturated this is why they are liquid.

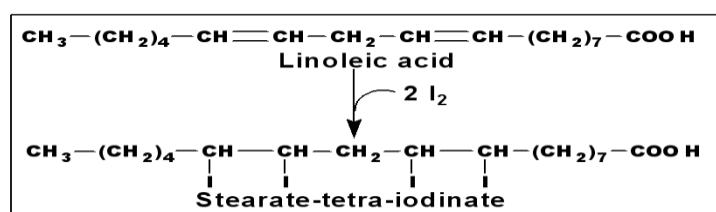
*Chemical Properties :

A. Hydrolysis: heated steam , acid, enzyme (e.g., lipase of pancreas) and this will produce three ionized fatty acids with a glycerol

B. Saponification: which is a special type of hydrolysis " Alkaline hydrolysis " produces salts of fatty acids (ionized fatty acids and Na⁺ that is found in the basic medium → "soaps") . Soaps cause emulsification of oily material. They are fatty acid salts.

C. Halogenation: halogens added to unsaturated F.A (e.g., iodine or

iodination) so the halogen will be distributed on the sites of the double



bonds .

- this reaction is used to :

1) determine if the fatty acid is saturated or not .

2)determine the degree of unsaturation of the fat or oil that determines its biological value depending on the amount of halogen used

D. Hydrogenation or hardening of oils:

-It is an addition reaction (H at the = of unsaturated F.A)

-Done under high pressure of hydrogen

-It is the base of hardening of oils (margarine manufacturing)

-Hydrogenation of oils converts some cis-double bonds to trans- double bonds (trans is bad for health)

*Advantages: more pleasant as cooking fat, easily stored & transported, less liable to rancidity

*Disadvantages: loss of fat-soluble vitamins (A, D, E & K) & essential fatty acids

E. Oxidation (Rancidity)

-Oxidation of fatty acids by atmospheric oxygen, light, moisture, bacterial or fungal contamination &/or heat

- It is a toxic reaction of triglycerides (food poisoning & cancer)
 - Leads to the development of unpleasant odor or taste or abnormal color particularly on aging.
 - Saturated fats resist rancidity more than unsaturated fats
 - It is the base for drying oils after exposure to atmospheric oxygen, e.g; paints & varnishes manufacturing
 - Rancidity destroys the fat-soluble vitamins (A, D, K & E)
 - Rancidity destroys the polyunsaturated essential F.A
 - Rancidity causes economical loss because rancid fat is inedible
- +Triacylglycerol is colorless
 - +Inedible : means not digestible .

After finishing the first type of simple lipids that is Triacylglycerols , we will talk about another type that is Waxes.

2) Waxes :

A. Solid simple lipids containing a monohydric alcohol (C16 ~ C30, higher molecular weight than glycerol) esterified to long-chain fatty acids (C14 ~ C36).
Examples: palmitoyl alcohol

B. Insoluble in water & Negative to acrolein test (turns glycerol to acrolein which gives a very bad odor)

C. Are not easily hydrolyzed (compared to fats) & are indigestible by lipases (but they are good for skin)

D. Are very resistant to rancidity

E. Are of no nutritional value

F. Coatings that prevent loss of water by leaves of plants.
example: Beeswaxes .

Differences between neutral lipids & waxes

Property	Waxes	Neutral lipids
1.Digestibility	Indigestible (not hydrolyzed by lipase)	Digestible (hydrolyzed by lipase)
2-Type of alcohol	Long-chain monohydric alcohol + one fatty acid	Glycerol (trihydric) + 3 F.A
3-Type of F.A	Mainly palmitic or stearic acid	Long & short chain F.A
4-Acrolein test	Negative	Positive
5-Rancidability	Never get rancid	Rancidible
6-Nature at room temperature	Hard solid	Soft solid or liquid
7-Saponification	Nonsaponifiable	Saponifiable
8-Nutritive value	No nutritive value	Nutritive
9-Example:	Bees & carnuba waxes	Butter & vegetable oils

#Compound (conjugated lipids) :

- They are lipids that contain additional substances, e.g., sulfur, phosphorus, amino group, carbohydrate, or proteins beside fatty acid & alcohol

- Classified into the following types according to the nature of the additional group

1.Phospholipids

2.Glycolipids

3.Lipoproteins

4.Sulfolipids & amino lipids

Thank you all , Love you all ;)