University of Jordan
Faculty of Medicine

Medical Committee
The University of Jordan

Introduction to

BIOCHEMISTRY

Lecture #: (.....4.....)

■ Sheet ☐ Slides ☐ Other

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Price: .....

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Definition and general properties refer to slide no. 2

- Lipids: macromolecules made from Alcohol and Fatty acid bonded by ester linkage.

- Amphipathic in nature: they have a polar part and non-polar part. According to the relative size of the hydrophobic and hydrophilic portions, they are either soluble in water or in organic solvents such as: acetone and ether.
- Lipids are not all fats; there are many types like waxes and oil.

- They are present wildly in both animals and plants.

Function and biological importance refer to slides no. 3 & 4

- They are storable to unlimited amount.
  Carbohydrates are stored as glycogen only in liver and skeletal muscles, “can’t be stored in every cell”.
  Proteins can’t be stored in the body, and they are made when needed only.
  so, only fats provide long term storage of energy for many reasons that include:
    - It's water insoluble, so they will pack on top of each other away from water.

    - High amounts of energy per gram, so it would take up less space than carbohydrates or proteins, which have a lower energy per gram value.

- Energy sources as they have a high-energy value (25% of body needs) & they provide more energy per gram compared to energy obtained per gram from carbohydrates & proteins.

- Important constituents of the nervous system.
  Most of the structure of the nervous system-other than its neurons- is composed of cerebrosides, fats and Schwann cells which are important for signal transduction.

- Lipids are an essential constituent of cell membranes.
  It is mainly made from phospholipids, which are important in transport, Separation and isolation of the intracellular and extracellular environments.

- Lipids supply us with **essential** fatty acids.

  Essential material: is a material that body can NOT produce, so the body has to obtain it from outside.

- Some vitamins are soluble in fat so they supply the body with vitamins “A, D, E & K”.

- lipids are stored in all human cells & acts as:
  - Store of energy.
  - Pad for the internal organs they cushion the internal organs from external shocks and present between the organs.
  - Subcutaneous thermal insulator against loss of body heat.

- Lipoproteins, they provide a way to transport the lipids inside the body around the blood, two types HDL and LDL.

- Cholesterol is an important constituent of the cell membrane that gives fluidity, important in the synthesis of: some hormones “cortical and adrenal hormones”, vitamin D3 & bile acids, which help in fat emulsification, which increases surface area of fats for enzyme action.

- Lipids provide bases for dealing with diseases that have relations with lipids such as obesity, atherosclerosis, lipid-storage diseases, essential fatty acid deficiency, respiratory distress syndrome : there is a surfactant on lungs that is made from lipids

Classification of lipids relate to slide 5

Lipids can be classified by structure according to:

- Open chain form. E.g.: triacylglycerols and Glycolipids.
- Cyclic form. E.g.: cholesterol and steroids.

Classified by structure according to

- Simple: made only from lipids.
- Compound "conjugated": made from lipids but with other things in it that are not lipids.
  "The same classification can be used for proteins, conjugated proteins like hemoglobin that has a (heme) group which is not an amino acid".
- Derived Lipids: material that can give rise to lipid structure upon hydrolysis or breakdown.
- Lipid-associating substances.

Classified by function to:

- Storage Lipids.
- Structural Lipids. E.g.: lipids in Membranes.
- Lipids as Signals, Cofactors & Pigments.

We will follow the second classification "*underlined and italic*"

Fatty alcohol refer to slides 6 – 8

They are two main fatty alcohols used to make lipids:

- Glycerol, which forms glycerolipids.
- Sphingosine, which forms sphingolipids.

Glycerol

- It is a trihydroxylic alcohol “has three hydroxyl groups.
- Has the popular name glycerin.
- Synthesized from glucose ← 1st relation between carbohydrates and lipids.
- Properties:
  - Colorless viscous oily liquid with sweet taste.
  - On heating with sulfuric acid or KHSO4 (dehydration) it gives acrolein that has a bad odor.
    That’s called the acrolein test which is used to detect the presence of glycerol and glycerol derivatives.
  - Combines with three molecules of nitric acid to form trinitroglycerin, which is used as a vasodilator “given under the tongue” or if turned cyclic and given 3 nitric groups it gives TNT.
  - It has a nutritive value by conversion into glucose intermediates & it enters in structure of phospholipids.
  - On esterification with fatty acids it gives:
    - One fatty acid + glycerol: Monoglyceride or monoacyl-glycerol.
    - Two fatty acids + glycerol: Diglyceride or diacyl- glycerol.
    - Three fatty acids + glycerol: Triglyceride or triacyl-glycerol.

Sphingosine

- Monohydric alcohol present in sphingolipids.
- Synthesized from serine (an amino acid) and palmitic acid (a fatty acid).
- It gives NEGATIVE with acrolein test: because it's not glycerol.

Fatty Acids refer to slides 9 - 10

- Aliphatic mono-carboxylic acids “hydrocarbon chain with one carboxylic group”.
- Mostly obtained from hydrolysis of natural fats & oils.
- Have the general formula R-$(CH2)_n$-COOH, where "n" is mostly an even number.
- The hydrocarbon chain usually from 2 to 34 carbons.
- Mostly have straight chain; a few exceptions have branched rarely cyclic.
- They are Amphipathic molecules that form bilayers & micelles “rounded structures that transport materials around the body”.

Naming and writing Structure

- C1 is carboxylic group, with the Hydrogen “COOH” or without it “COO-“depending on the pH of the medium.
- The chain can be saturated or unsaturated “monounsaturated or polyunsaturated”.
- Most naturally occurring are CIS isomers and very rare TRANS isomers.
- You have to specify on which "n" carbons is the double bond “using Δ^n then writing the number of double bonds in front of the delta symbol”.

Physical properties refer to slide 11

1. Solubility

The longer the chains -> the less soluble, due to increase in hydrocarbon chain which is hydrophobic.

Double bonds add kinks -> increase the solubility, as they prevent good packing of fatty acid molecules.

2. Melting point

The longer the chain -> higher melting point, more energy to turn it to liquid due to more packing.

Double bonds -> decrease the melting point.

The more unsaturated, the lower is the melting point.

Classification of fatty acids refer to slides 12-14

Saturated -> short

Medium

Long

Unsaturated -> monounsaturated

Polyunsaturated

Saturated

- No double bonds.
- 2 – 24 carbon atoms approximately which can be odd or even, but usually it's even, because in their synthesis 2 carbon units are added each time.
- Solid at room temperature except the short chained which are liquid.

- Long chain are insoluble in water where medium and short chains are soluble in water
- molecular formula, C(n)H(2n+1)COOH (+1) because the terminal carbon is CH3
- in omega nomenclature you take the terminal CH3 as Carbon 1 , then state the number of the first double bond from it : omega 3 , omega 1 etc

Short chained f.a. **Up to 6 C atoms**	**Medium chained f.a.** **Up to 10 C atoms**	**Long chained f.a** **More than 10 C atoms**
Liquid at room temperature	Solid at room temperature	Solid at room temperature
Water soluble	Water soluble	Water insoluble
Volatile at room temperature	Non-Volatile at room temperature	Non-Volatile at room temperature

- Long chain f.a. occur in hydrogenated oils, animal fats, butter & coconut & palm oils

Important Short chained fatty acids

Acetic f.a. : 2 carbons

Butyric f.a. : 4 carbons

Caproic f.a. : 6 carbons

Important Medium chained fatty acids

Caprylic acid (8C)

Capric acid (10C)

Important long chained fatty acids

Palmitic: 16 carbons

stearic : 18 carbons

Unsaturated fatty acids refer to slides 14 & 15

- Monounsaturated: they contain one double bonds with the formula C(n)H(2n-1)COOH.
- Polyunsaturated: they contain more the one double bond C(n)H(2n-more than 1)COOH.
- Do not pack closely due to kinks by the CIS double bond , “the trans double point” don’t form kinks”.

Important monounsaturated fatty acids

Oleic acid: most common fatty acid in natural fats

It is C18:1∆9

Important polyunsaturated fatty acids

Linoleic:

C18:2∆9, 12

It is the most important since other essential fatty acids can be synthesized from it in the body. ω6

Linolenic acid:

C18:3 ∆9, 12, 15

In corn, peanut, olive, cottonseed & soybean oils. ω 3

Linoleic and linolenic fatty acids are also essential fatty acids.