AlAYEN IRAQI UNIVERSITY
Health and Medical Technologies
Anesthesia Department

General Chemistry

Lipids

Lec10

- Lipids are organic compounds found in living organisms that are soluble in nonpolar organic solvents. *Unlike the polysaccharides proteins and nucleic acids lipids are not polymers.They are mostly small molecules

- General properties of lipids:
- 1-Lipids are relatively soluble in organic solvents such as chloroform and methanol.
- 2-Lipids are insoluble in water.

Classification of lipids

- Lipids are classified into three main groups:
- I. Simple lipids: Esters of fatty acids with various alcohols which have two subtypes.
- a. Neutral fats: Esters of three fatty acids with glycerol.
- b. Waxes: Esters of fatty acids with higher molecular weight monohydric alcohols.

- II. Compound lipids: In addition to esters of fatty acids with alcohol, they contain other groups.
- They include:
- a. Phospholipids: Lipids containing phosphate in addition to fatty acids and alcohol.
- b. Glycolipids (glycosphingolipids): containing a fatty acid, sphingosine, and carbohydrate.

- III. Derived lipids: They are produced by hydrolysis of the first two groups or they are
- present in association with them in nature.

- It includes saturated and unsaturated fatty acids, cholesterol, steroids, alcohols, fatty aldehydes, ketone bodies, and carotenoids.

Compound Lipids

They contain fatty acids, alcohols and other groups. According to the type of the attached group they are classified into:

1- Phospholipids: Containing phosphate radicals.

2- Glycolipids: Containing carbohydrate radicals.

1- Phospholipids

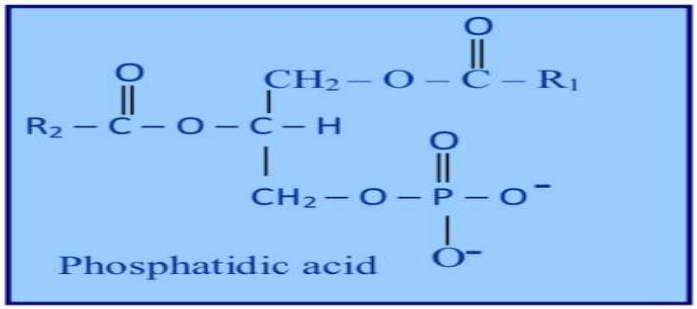
They are classified according to the alcohol present into two main sub-groups:

A- Glycerophospholipids: Containing glycerol.

B- Sphingomyelin: Containing sphingosine (sphingol).

A- Glycerophospholipids(Glycerophosphatides):

They are phospholipids containing glycerol. They include phosphatidic acid and its derivatives as follows:



1. Phosphatidic acid (Diacylglycerolphosphate):

On hydrolysis: It gives one glycerol, one saturated fatty acid (usually at position 1), one unsaturated fatty acid (usually at position 2), and phosphoric acid.

2. Lecithin (Phosphatidylcholine):

It is formed of phosphatidic acid and choline. It is usually present in the cell membranes especially in the liver, lung and brain. It is also present in blood plasma.

3. Cephalin (Phosphatidylethanolamine):

It is formed of phosphatidic acid and ethanolamine. It is present in the cell membranes and blood plasma.

4. Phosphatidylserine:

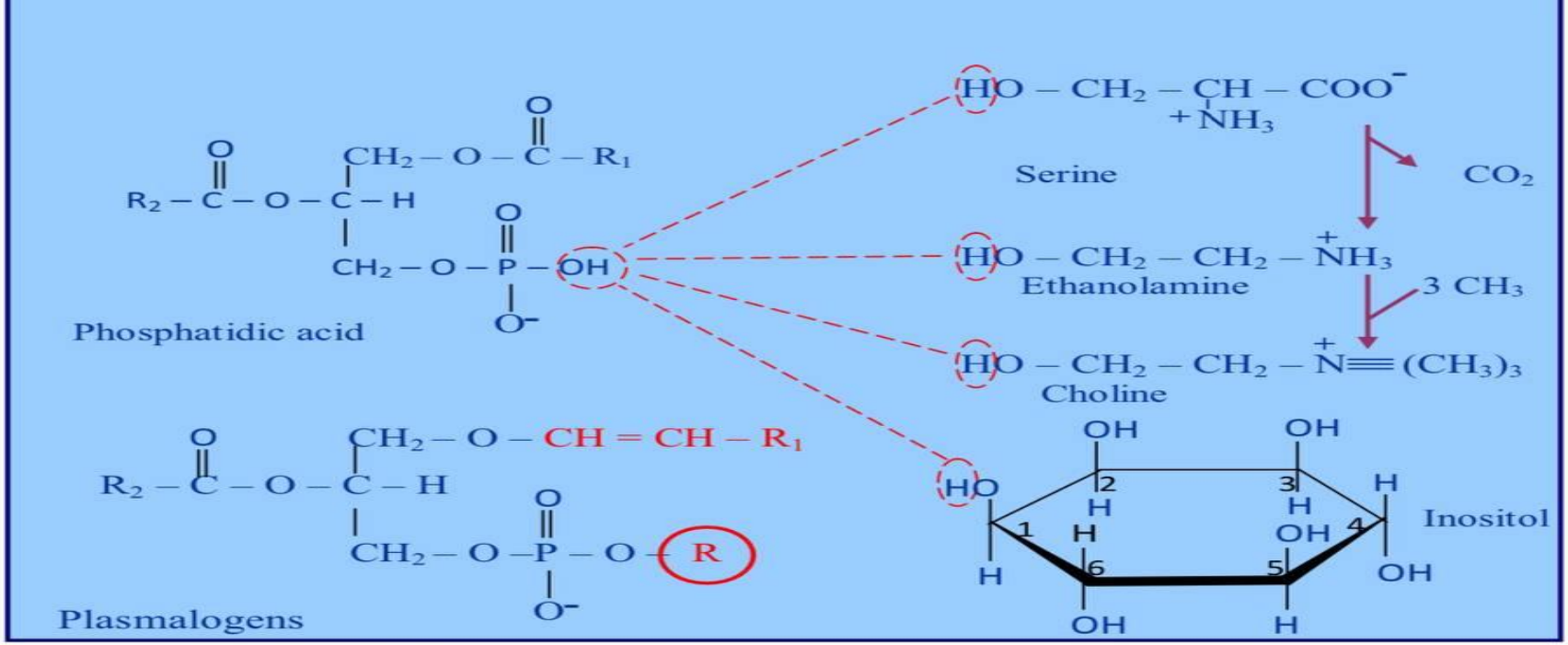
It is formed of phosphatidic acid and serine amino acid. It is present in cell membranes.

5. Phosphatidylinositol (Lipositol):

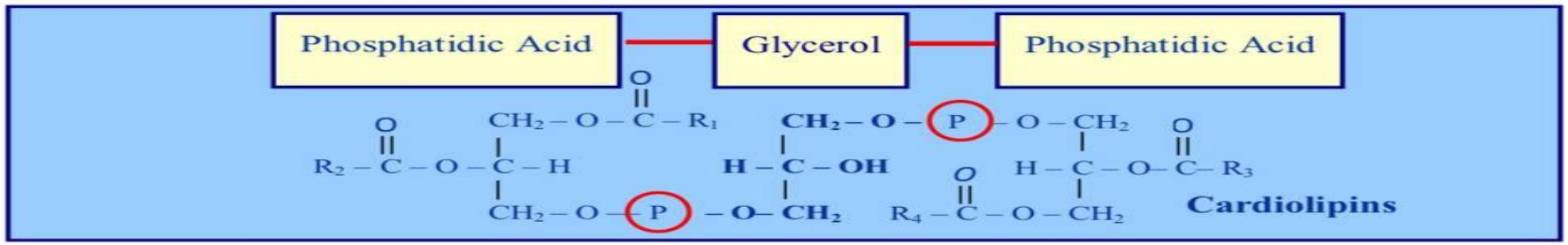
It is formed of phosphatidic acid and inositol. It is present in cell membranes. Phosphatidylinositol 4,5-bisphosphate (PIP_2) acts as secondary messenger in the process of intracellular signal transduction (explained later on).

6. Phosphatidylglycerol:

It is formed of phosphatidic acid and glycerol.



7- Cardiolipins (Diphosphatidylglycerol): **They are formed of two molecules of phosphatidic acid connected by a molecule of glycerol**. So, they contain 4 FAs, 3 glycerol and 2 phosphates. They form an important component of inner mitochondrial membrane.



8- Plasmalogens:

Plasmalogens are a type of **ether phospholipid** characterized by the presence of an enol form of fatty alcohol in ether linkage at the position-1, a fatty acid at the position-2 and an R group at the position-3. The R-group is in the form of **ethanolamine or choline**. Plasmalogens are found in numerous human tissues e.g. nervous and cardiovascular system. Reduced levels of brain tissue plasmalogens have been associated with **Alzheimer Disease.**

Metabolism The chemical processes occurring within a living cell or organism that are necessary for the maintenance of life. All these are called anabolism and catabolism.

Lipid metabolism is the synthesis and degradation of lipids in cells, involving the breakdown and storage of fats for energy and the synthesis of structural and functional lipids, such as those involved in the construction of cell membranes . In animals, these fats are obtained from food and are synthesized by the liver Lipogenesis is the process of synthesizing these fats The majority of lipids found in the human body from ingesting food are triglycerides and cholesterol Other types of lipids found in the body are fatty acids and membrane lipids. Lipid metabolism is often considered as the digestion and absorption process of dietary fat however, there are two sources of fats that organisms can use to obtain energy. from consumed dietary fats and from stored fat. Since lipids are hydrophobic molecules, they need to be solubilized before their metabolism can begin.

Lipid metabolism often begins with hydrolysis) which occurs with the help of various enzymes in the digestive system.

What is a lipid abnormality?

The liver produces cholesterol and triglycerides. When the blood contains amounts of these substances that are outside of the healthy range—either too high or too low—this is known as a lipid disorder. People who have a high amount of certain lipids are at increased risk of developing cardiovascular disease.

Abnormalities of lipid metabolism

reported before the use of HIV-1 PIs include increases in serum triglycer- ides and decreases in total and high-density li- poprotein cholesterol (HDL-C)] that occurred.

What are proteins

- Proteins are biological molecules performing a wide variety of functions. For instance, some proteins catalyse a reaction, i.e. they make it go faster than it normally would: those proteins are called enzymes. Other proteins transport molecules throughout the body, others yet provide structural support for cells so they have the right shape, etc.

- Proteins are involved in nearly every biological process and their function is very often tightly linked to their three-dimensional structure. Therefore, it is crucial to determine the structure of a protein in order to understand fully how it works inside a cell. The many functions of proteins are reflected by the wide variety of 3D structures they adopt. However, all proteins are made of the same constitutents: amino acids.

CLASSIFICATION OF PROTEINS

- ## Classification Based on Functions

1. Catalytic proteins, e.g. enzymes
2. Structural proteins, e.g. collagen, elastin
3. Contractile proteins, e.g. myosin, actin.
4. Transport proteins, e.g. hemoglobin, myoglobin, albumin, transferrin
5. Regulatory proteins or hormones, e.g. ACTH, insulin, growth hormone
6. Genetic proteins, e.g. histones
7. Protective proteins, e.g. immunoglobulins, interferons, clotting factors.

Classification based on Composition and Solubility

According to this classification, proteins are divided into three main groups as simple, conjugated and derived proteins.

Simple proteins On hydrolysis gives only amino acids , Examples: Albumin and globulins

Conjugated proteins They are combinations of protein with a non-protein part, called prosthetic group Conjugated proteins may be classified as follows

Glycoproteins, Lipoproteins, Nucleoproteins, Chromoproteins, Phosphoproteins, Metalloproteins:.

- Classification Depending on the Shape

1- Fibrous

1) polypeptides arranged in long strands or sheets

2) water insoluble (lots of hydrophobic AA's)

3) strong but flexible 4) Structural (keratin, collagen)

2- Globular

1) polypeptide chains folded into spherical or globular form

2) water soluble

3) contain several types of secondary structure

4) diverse functions (enzymes, regulatory proteins)

functions **of** Proteins

Proteins have multiple functions, including:

acting as enzymes and hormones,

maintaining proper fluid and acid-base balance,

providing nutrient transport, making antibodies,

enabling wound healing and tissue regeneration, and providing energy when carbohydrate and fat intake is inadequate

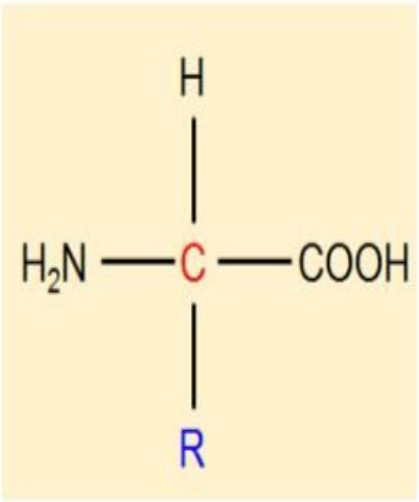
- A peptide bond also called an eupeptide bond, is a chemical bond that is formed by joining the carboxyl group of one amino acid to the amino group of another. A peptide bond is basically an amide-type of the covalent chemical bond. This bond links two consecutive alpha-amino acids from C1 (carbon number one) of one alpha-amino acid and N2 (nitrogen number two) of another. This linkage is found along a peptide or protein chain.

α-Amino Acids

–NH2 always attached to the α–carbon (the carbon attached to –COOH)

C = α–carbon

R = side chains



- There are 20 amino acids commonly found in proteins.

Amino Acid Requirements of Humans

Nutritionally Essential	Nutritionally Nonessential
Arginine[a]	Alanine
Histidine	Asparagine
Isoleucine	Aspartate
Leucine	Cysteine
Lysine	Glutamate
Methionine	Glutamine
Phenylalanine	Glycine
Threonine	Proline
Tryptophan	Serine
Valine	Tyrosine

[a] "Nutritionally semiessential." Synthesized at rates inadequate to support growth of children.

Nucleic Acids

- **Nucleic acids** are molecules that store information for cellular growth and reproduction

- There are two types of nucleic acids:
  - **deoxyribonucleic acid (DNA)** and **ribonucleic acid (RNA)**

- These are polymers consisting of long chains of monomers called nucleotides

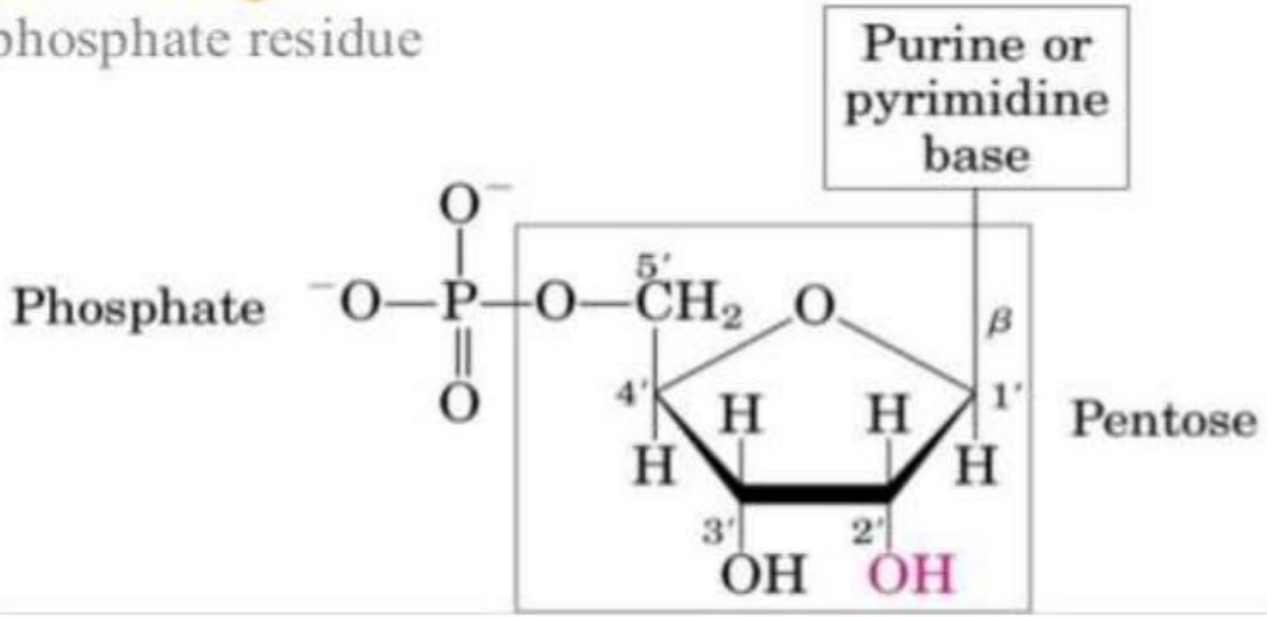
- A **nucleotide** consists of a nitrogenous base, pentose sugar and a phosphate group.

Nucleic Acids

DNA and RNA are nucleic acids, long, thread-like polymers made up of a linear array of monomers called nucleotides

All nucleotides contain three components:

1. A nitrogen heterocyclic base
2. A pentose sugar
3. A phosphate residue



- **Deoxyribonucleic Acid (DNA)** Chemically, DNA is composed of a pentose sugar, phosphoric acid and some cyclic bases containing nitrogen. The sugar moiety present in DNA molecules is β-D-2-deoxyribose. The cyclic bases that have nitrogen in them are adenine (A), guanine (G), cytosine(C) and thymine (T). These bases and their arrangement in the molecules of DNA play an important role in the storage of information from one generation to the next one. DNA has a double-strand helical structure in which the strands are complementary to each other.

- **Ribonucleic Acid (RNA)** RNA molecule is also composed of phosphoric acid, a pentose sugar and some cyclic bases containing nitrogen. RNA has β-D-ribose in it as the sugar moiety. The heterocyclic bases present in RNA are adenine (A), guanine (G), cytosine(C) and uracil (U). In RNA the fourth base is different from that of a DNA. The RNA generally consists of a single strand which sometimes folds back; that results in a double helix structure.

DNA replication is the process by which the genome's DNA is copied in cells. Before a cell divides, it must first copy (or replicate) its entire genome so that each resulting daughter cell ends up with its own complete genome.