

University of Baghdad  
College of Science  
Department of Chemistry  
General Biochemistry (1)  
3<sup>rd</sup> class

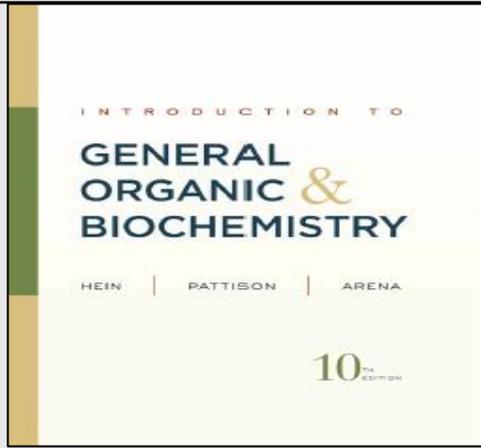
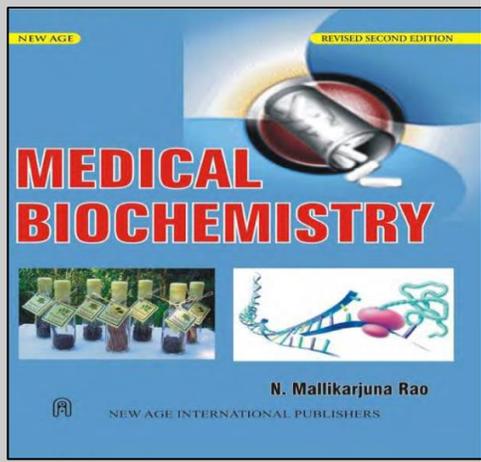
By

**Assist. Professor Dr. Thikra Hasan Mathkor**



# BIOCHEMISTRY - 3<sup>rd</sup> class/ Chemistry

Text books:

<b>Introduction To General, Organic, And Biochemistry</b>	<b>Morris Hein, Scott Pattison And Susan Arena</b>	<b>2012</b>	<b>10<sup>th</sup> edition</b>	<b>Printed in the United States of America.</b>	
<b>Medical Biochemistry</b>	<b>N. MALLIKARJUNA RAO</b>	<b>2006</b>	<b>1<sup>st</sup> edition</b>	<b>Printed in India</b>	

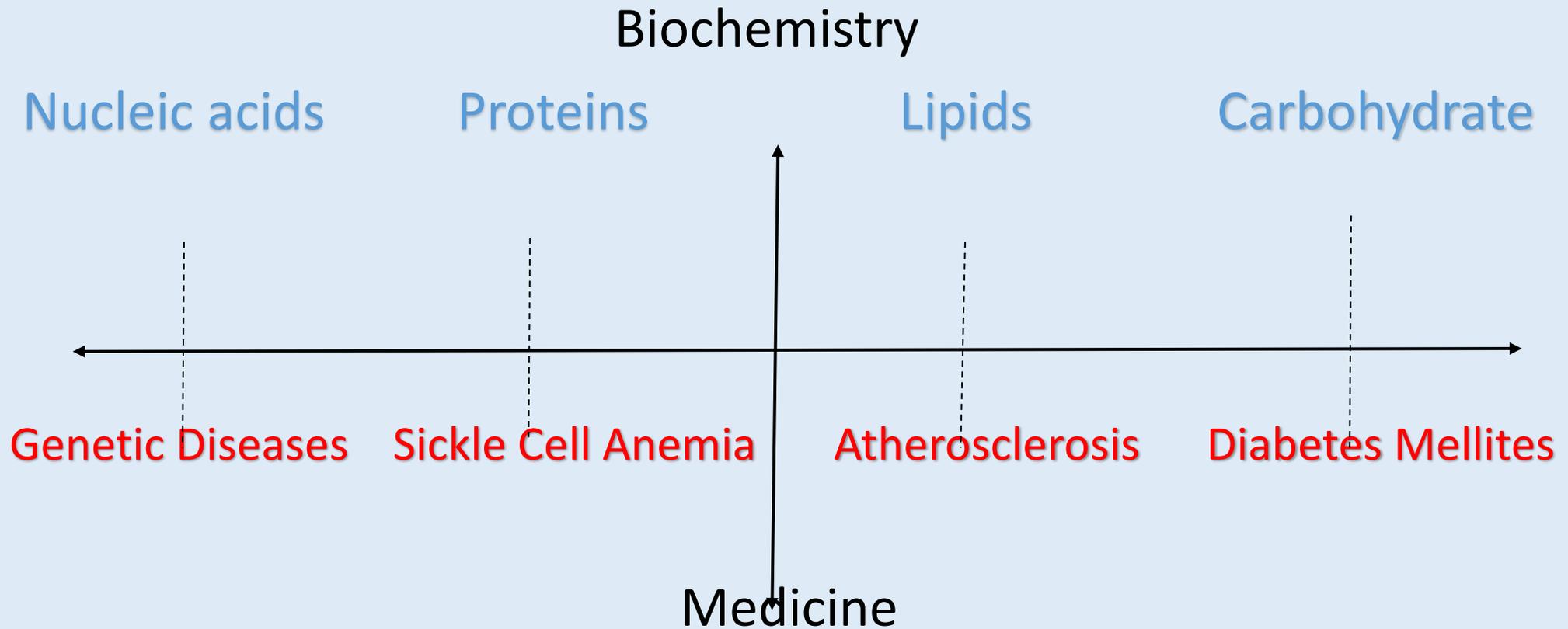


# The biochemistry importance:

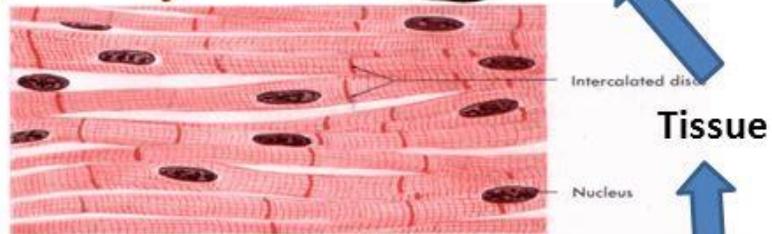
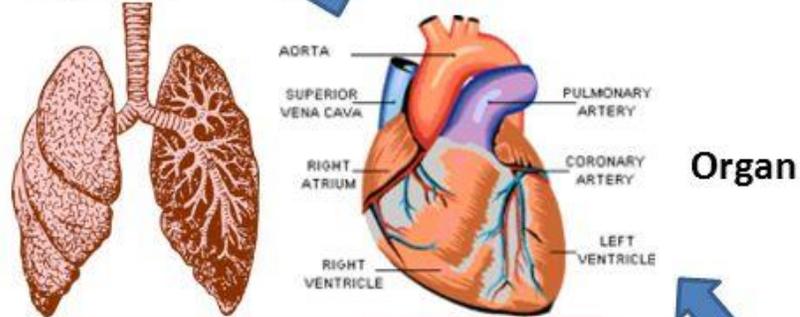
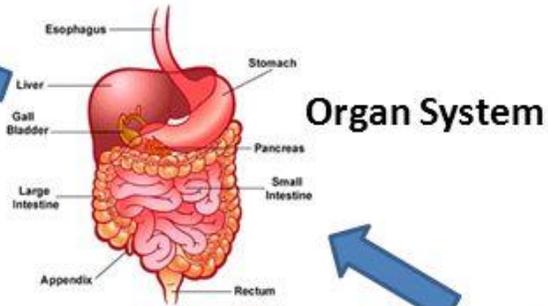
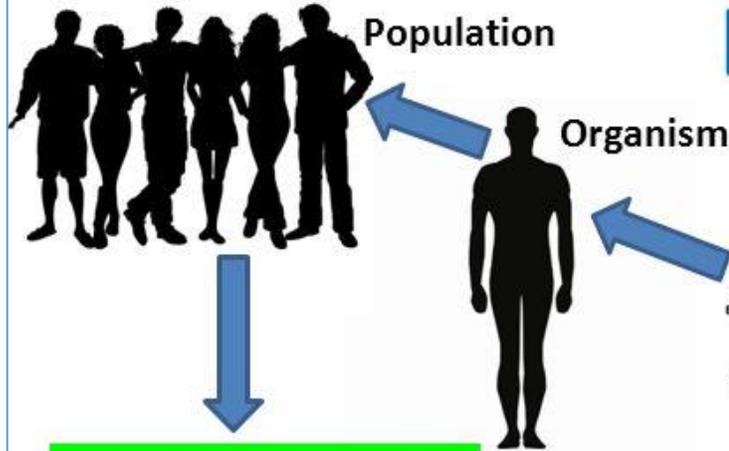
- Biochemistry covers a range of scientific disciplines, including genetics, microbiology, forensics, plant science and medicine. Because of its breadth, biochemistry is very important and advances in this field of science over the past 100 years have been staggering. It's a very exciting time to be part of this fascinating area of study.
- Provide new ideas and experiments to understand how life works
- Support our understanding of health and disease
- Contribute innovative information to the technology revolution



# Biochemistry Definition



# Levels of Organization



**What is a Community?**

- A community is formed from all living populations found in an area.
- All the foxes, dandelions, grasshoppers, snakes, hawks, deer, and skunks living in one area each form their individual populations, but together make up a community.

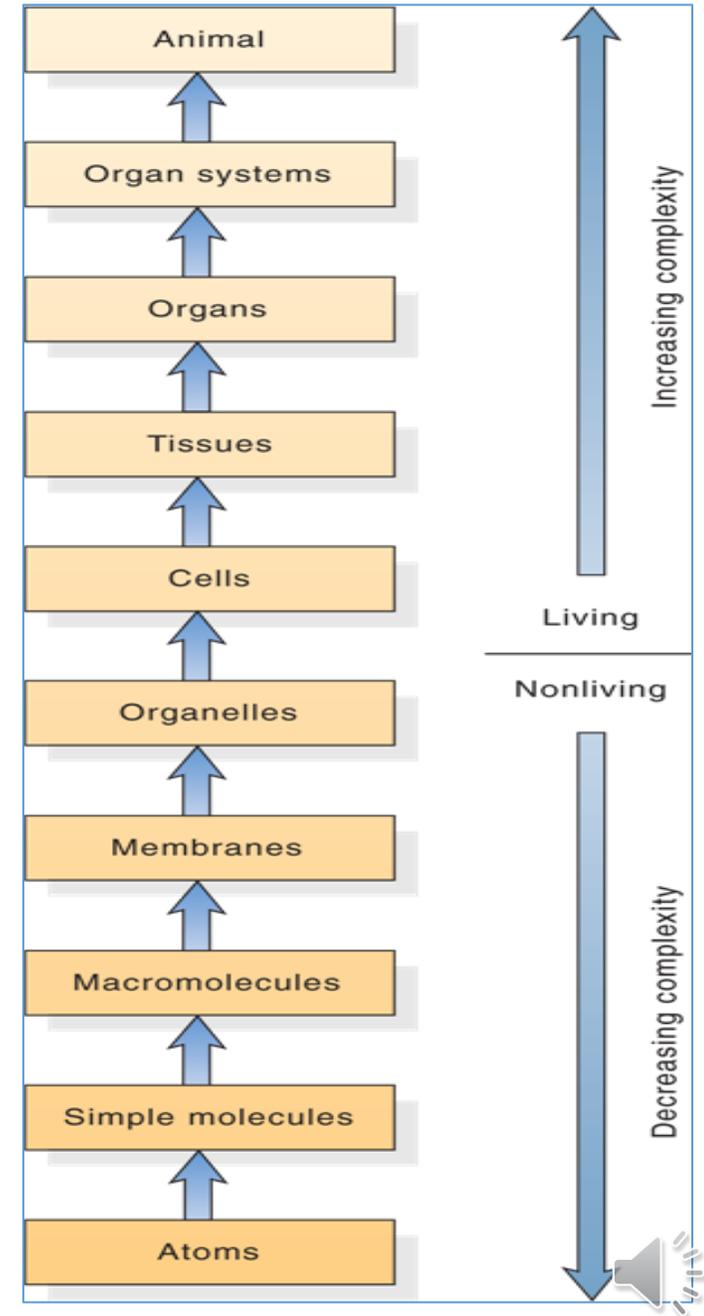
**Ecosystem**

Ecosystems are made up of **biotic** (living) and **abiotic** (nonliving) things.

- **Biotic:** bio means living.
 

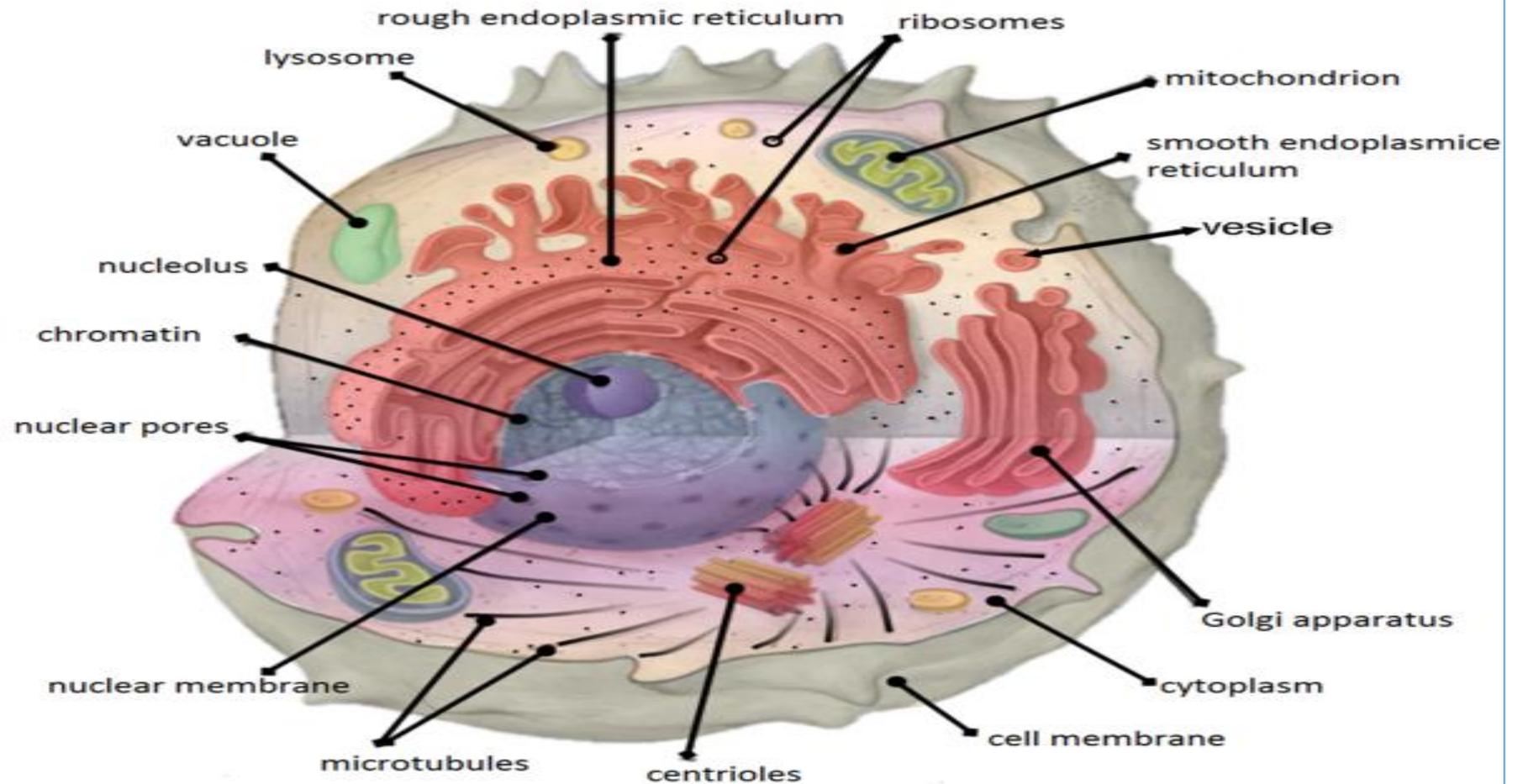
Plants	Animals	Microorganisms
- **Abiotic:** The prefix (a) means not, so abiotic means not living.
 

Temperature	Sunlight	Soil	Water	Rainfall



# Cell organelles' structure and function

- living organisms can be divided into two large groups—the **prokaryotes** and **eukaryotes**.



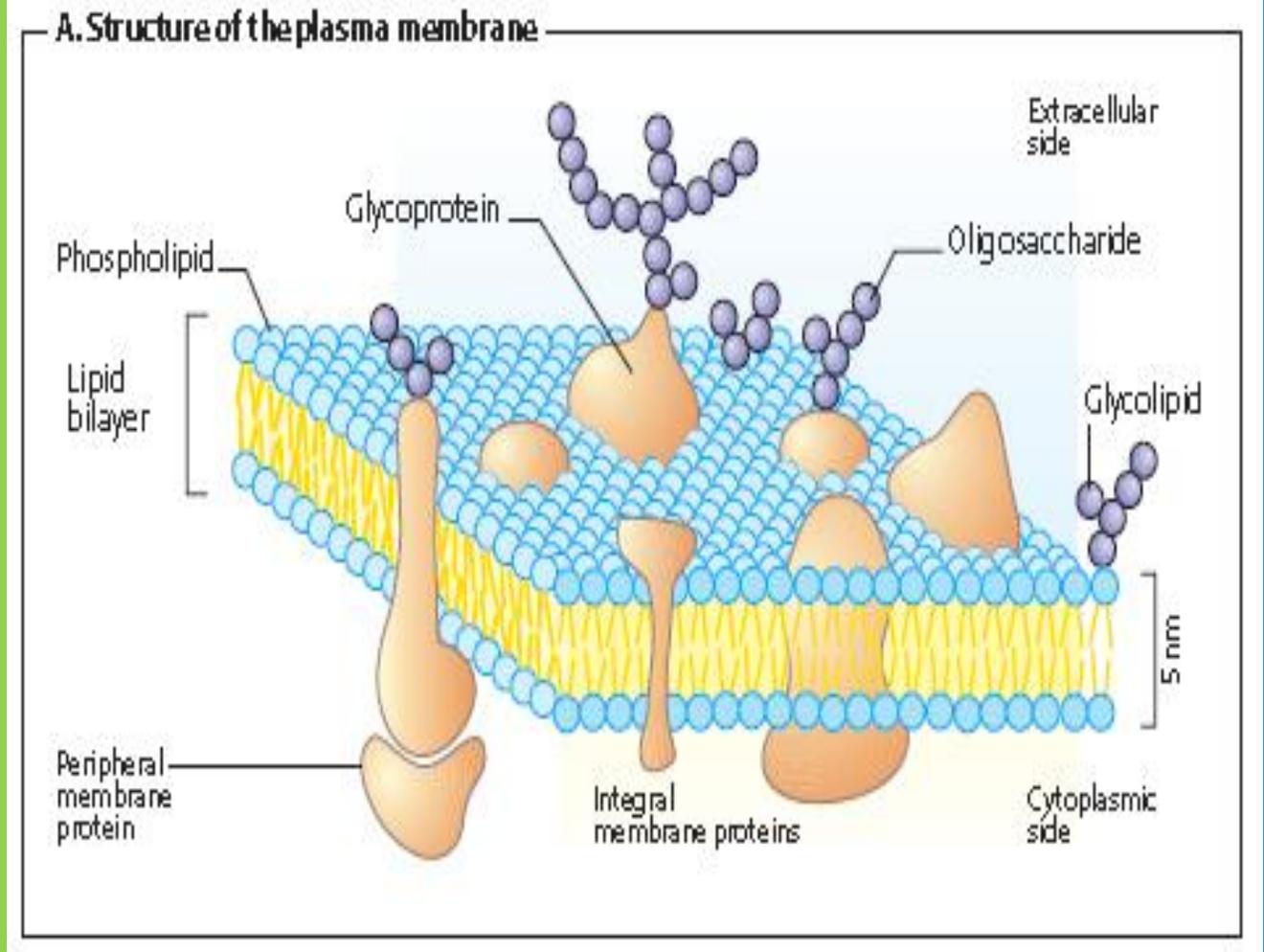
# Cell organelles' structure and function

## 1) Plasma membrane

All biological membranes consist of a continuous **bilayer of amphipathic lipids** approximately 5 nm thick, into which **proteins** are embedded and also carry **carbohydrates** (mono- and oligosaccharides) on their exterior, which are bound to lipids and proteins.

### Functions:

- 1. Enclosure and insulation of cells and organelles.
- 2. Regulated transport of substances
- 3. Reception of extracellular
- 4. Interactions with other cells
- 5. Anchoring of the cytoskeleton



# Cell organelles' structure and function

## 2) Cytoplasm:

It is the *central reaction space of the cell*. This is where many important pathways of the metabolism take place.

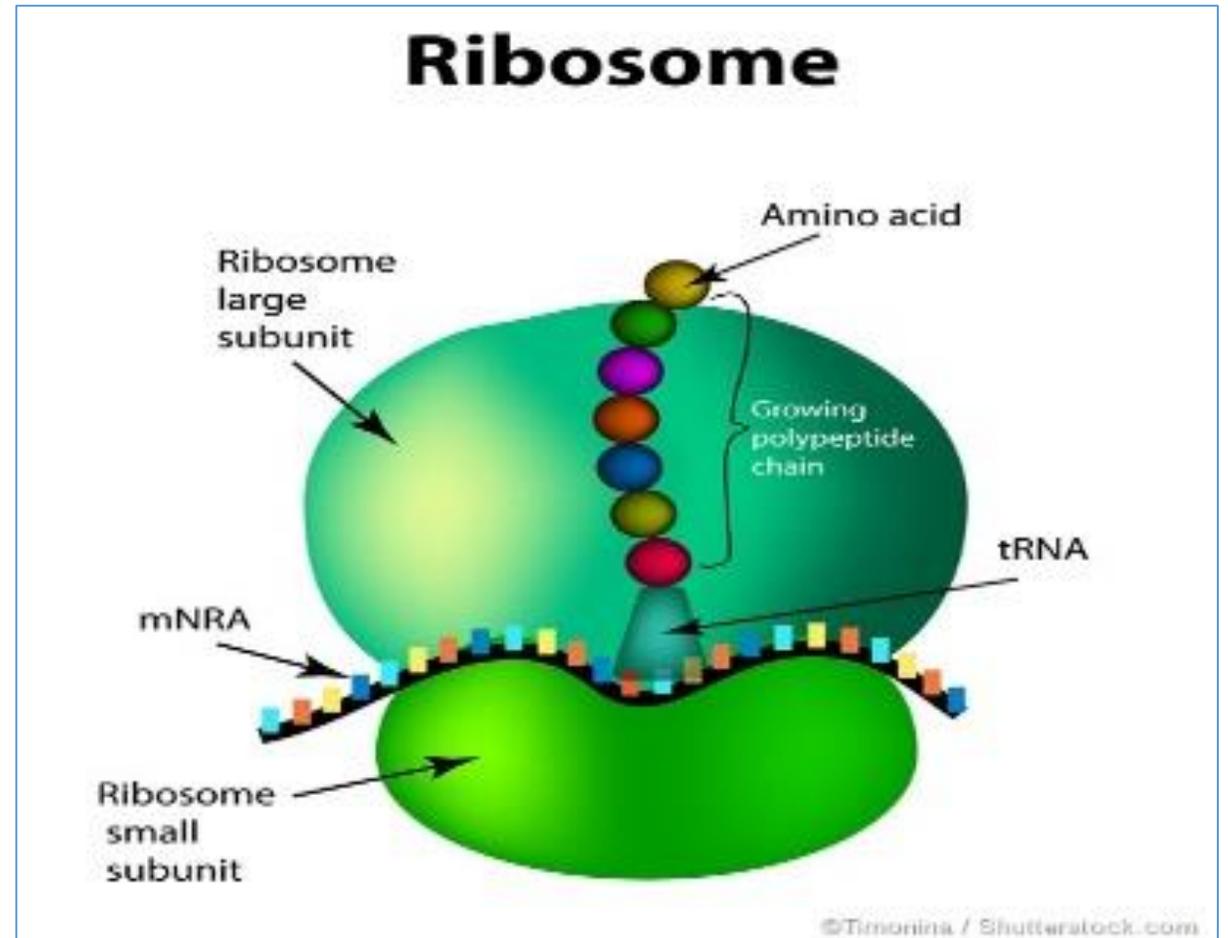
## 3) Cytoskeleton:

The structure of the cell, the shape of the cell surface, and the arrangement of subcellular organelles is organized by three major protein components:

1. Microtubules 2. Thin filaments 3. Intermediate filaments

## 4) Ribosome

The ribosome is made of ribosomal RNA molecules and proteins .



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# CARBOHYDRATE

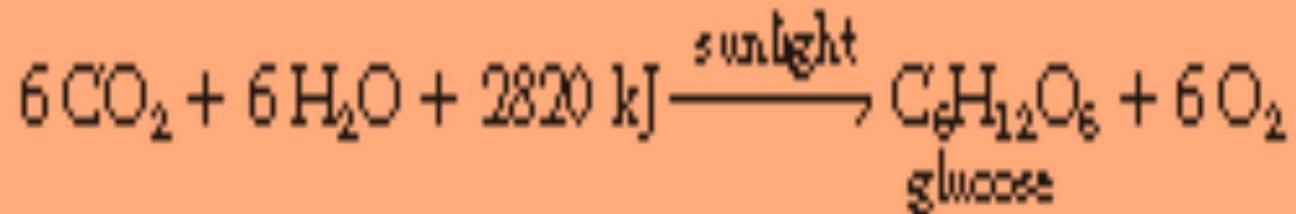
- **Importance of Carbohydrate**
- **Occurrence**
- **Definition**
- **Nomenclature of CHO**
- **Classification**
  - **Monosaccharides**
- \* **Physical Characters of Monosaccharides**
- \* **The main chemical reactions of CHO**
  - **Sugar derivatives**
  - **Oligosaccharides**
  - **Polysaccharides**

# Importance of Carbohydrate

1. They are the major source of energy to human beings
2. They act as storehouses of chemical energy (starch, glycogen)
3. Are components of supportive structure
4. They are component of many biological structure and molecules
5. Derivatives of CHO involved in :drugs , as vitamins , Anit- freeze glycoprotein.

# Occurrence

- Carbohydrate (CHO) in humans, animals, plant & microorganisms
- CHO are present in tissue fluids (mucos), blood, milk, .....
- In the plant, CHO is producing through Photosynthesis process:

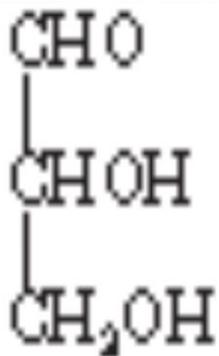


# Definition

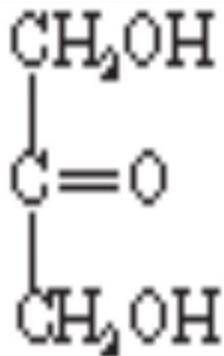
- **Carbohydrates (CHO)** are generally defined as polyhydroxy aldehydes or polyhydroxy ketones or substances that yield these compounds when hydrolyzed.
- General formula :  $C_nH_{2n}O_n / C_n(H_2O)_n$
- The ratio of carbon to water is one in most of CHO, hence the name carbo : hydrate = (1:1)

# Nomenclature of CHO

Trivial names



Glyceraldehyde  
(an aldotriose)

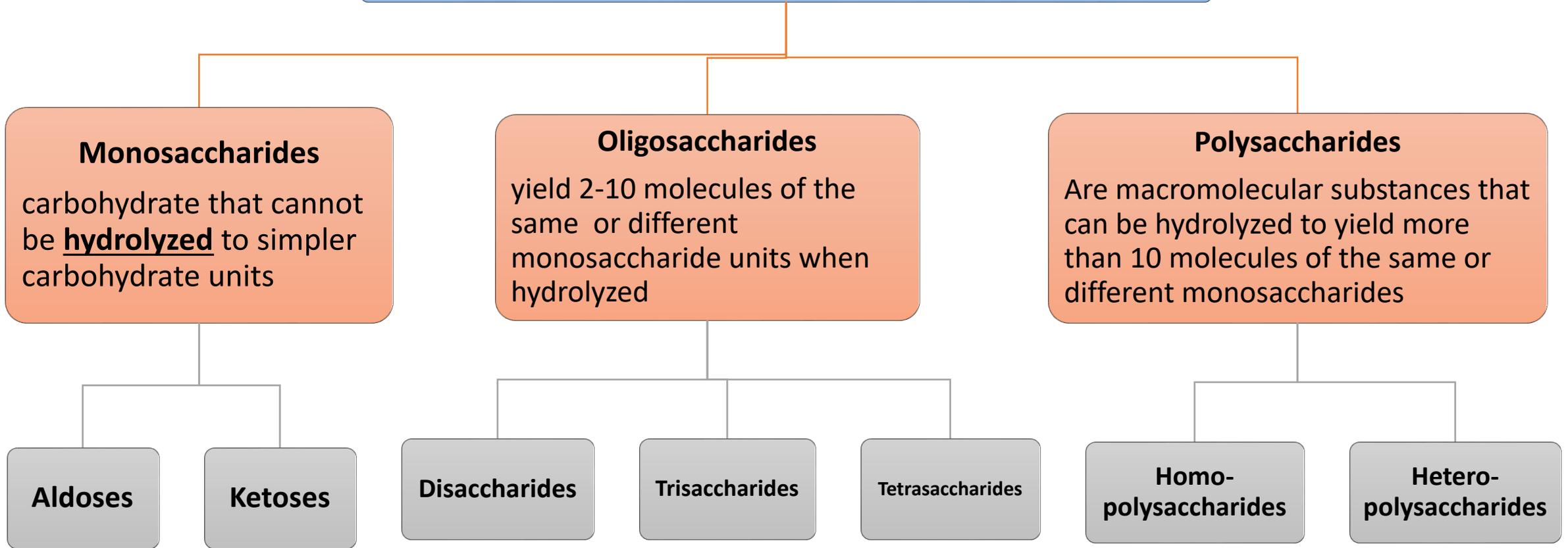


Dihydroxyacetone  
(a ketotriose)

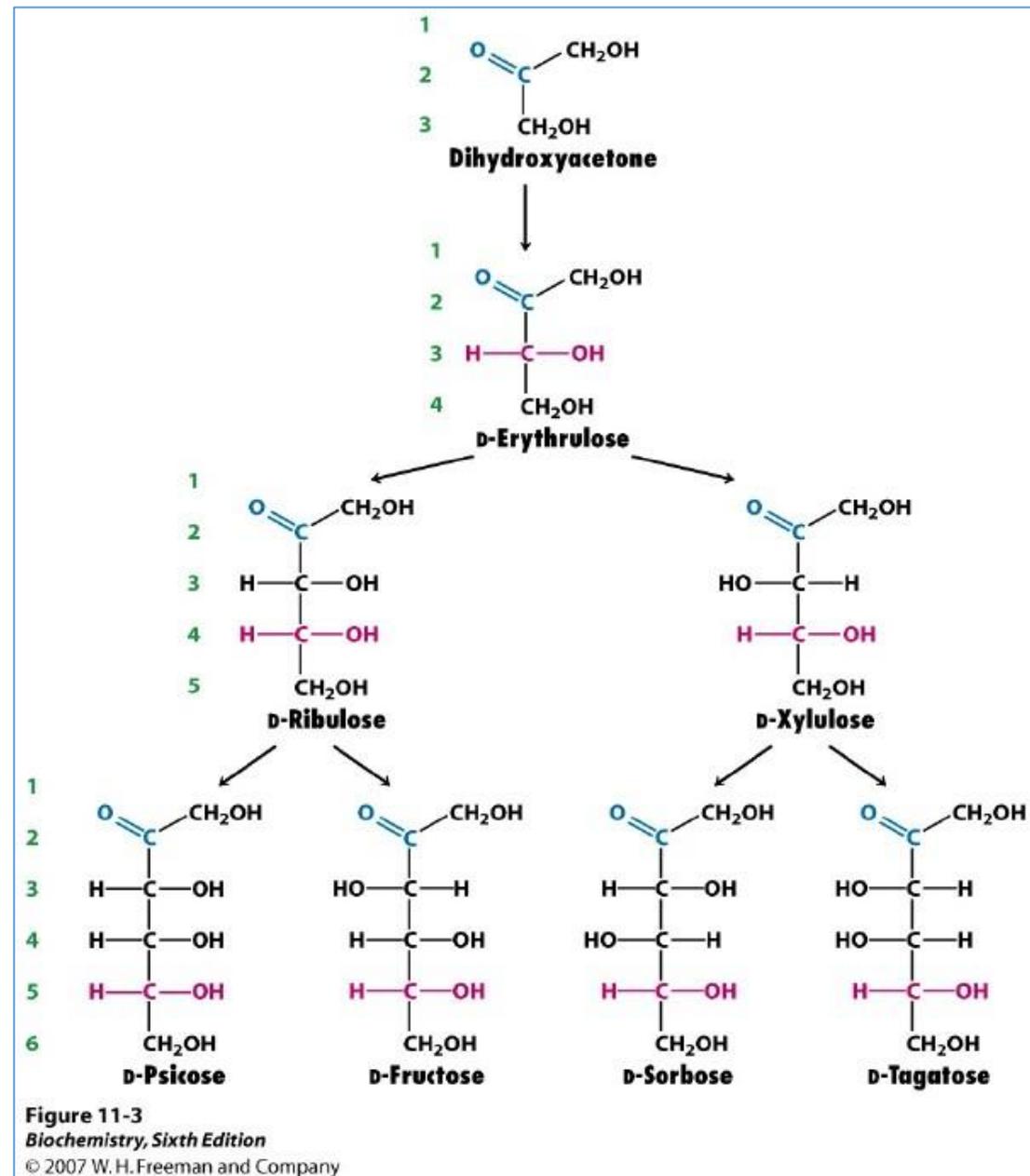
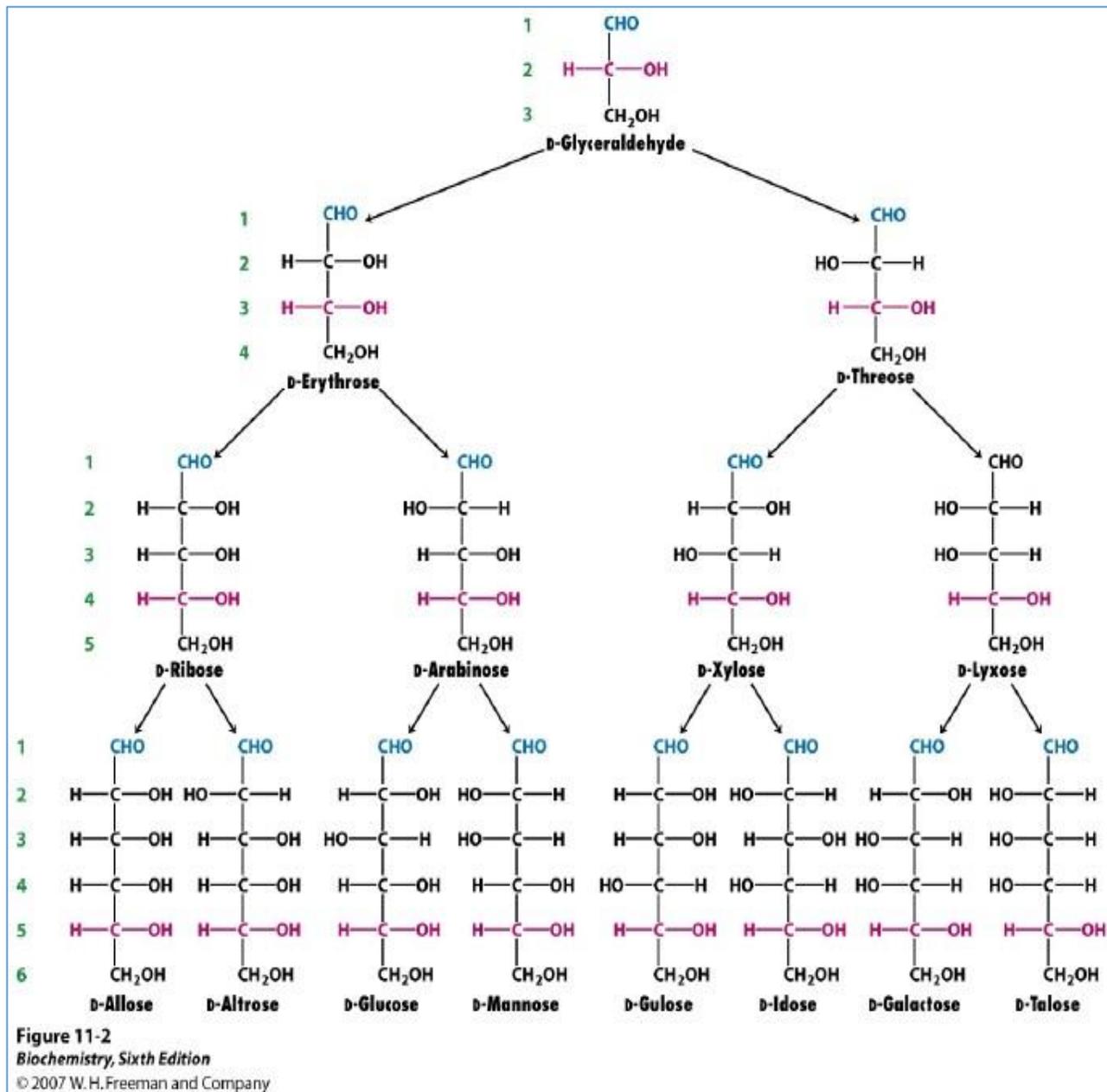
systematic names

- Aldo trioses
- Keto trioses

# Classification of Carbohydrates

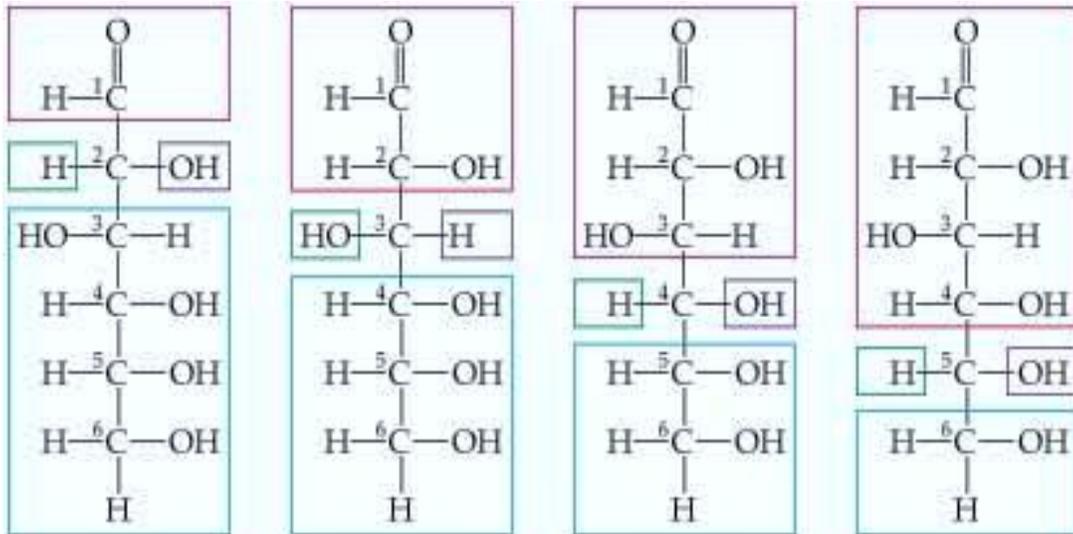
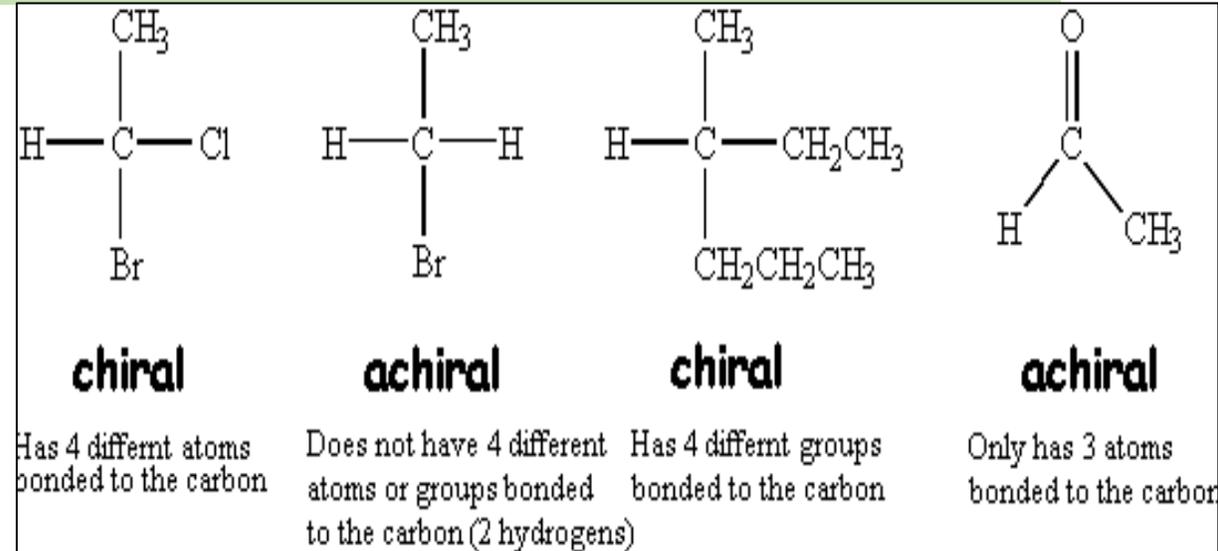


- 3C – Trioses
- 4C – Tetroses
- 5C – Pentoses
- 6C – Hexoses
- 7C – Heptoses



# Physical Characters of Monosaccharides

- 1- Monosaccharides are colorless, crystalline solids.
- 2- Asymmetric carbon: When four different atoms or functional groups are bonded to a carbon atom, the molecule formed is asymmetric, and the carbon atom is called an **asymmetric carbon atom** or **chiral carbon**



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# Physical Characters of Monosaccharides

**3- Isomers:** two or more compounds having the same number and kinds of atoms

Two compounds have the same molecular formula but different structural formula, like: butane and isobutene , ethanol and dimethyl ether

the isomers have the same structural formulas but differ in the spatial arrangement of the atoms. This type of isomerism is known as **Stereoisomerism**

**Epimers**

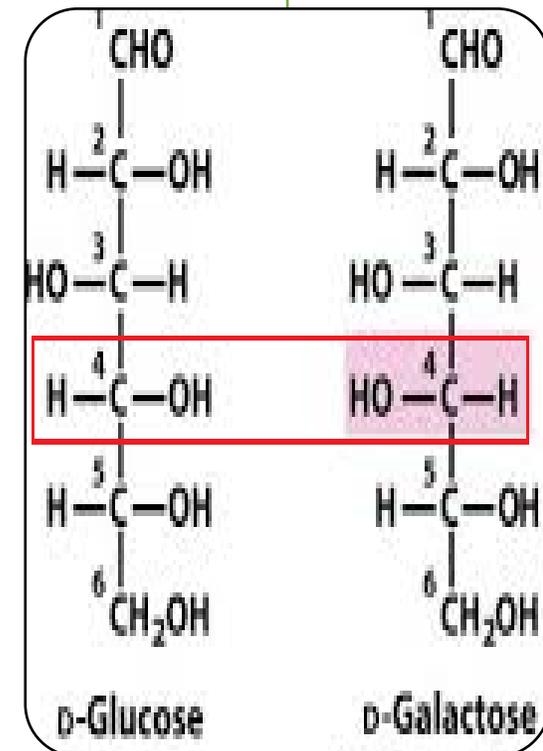
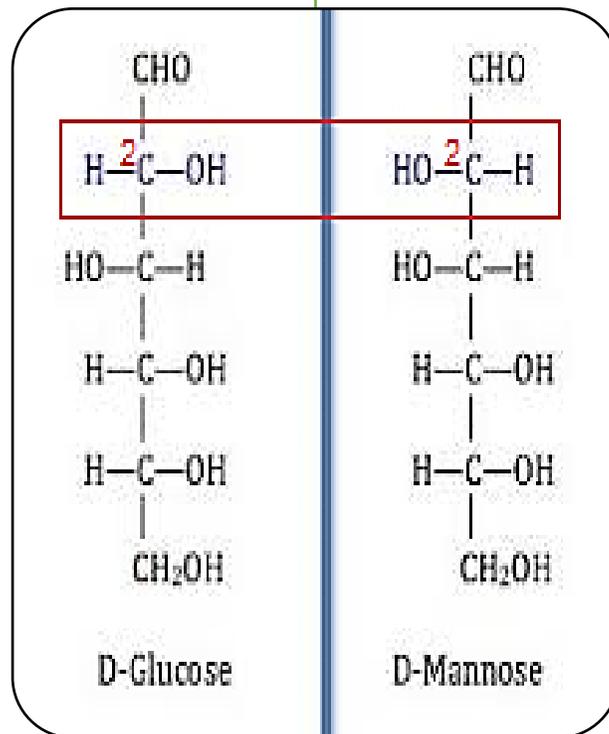
**Enantiomers**

**Optical Activity**

# Physical Characters of Monosaccharides

## Epimers

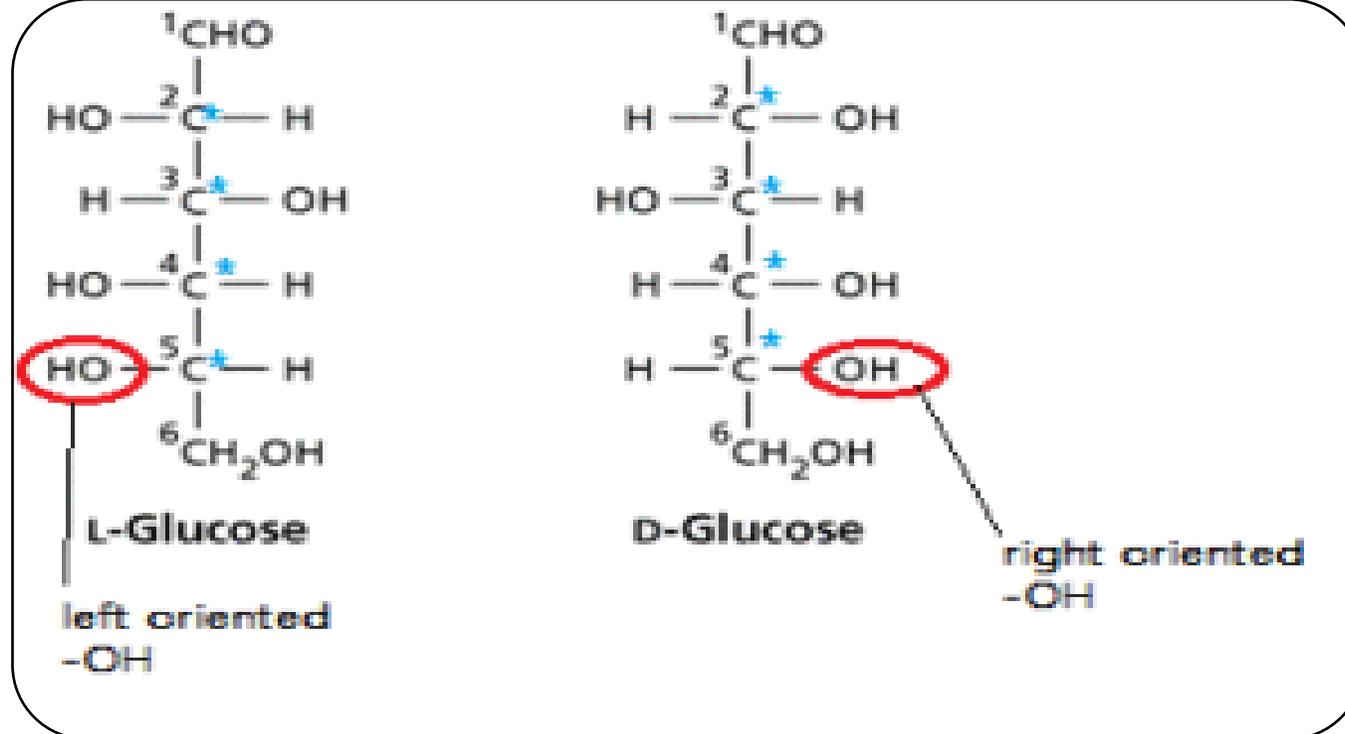
\* Differences in the configuration of  $\text{-OH}$  on 2<sup>ed</sup>, 3<sup>rd</sup> & 4<sup>th</sup> carbon atoms



# Physical Characters of Monosaccharides

## Enantiomers

- \* Their structure are mirror images of each other
- \* D & L sugars depending on the position on penultimate carbon atom (next to the last)



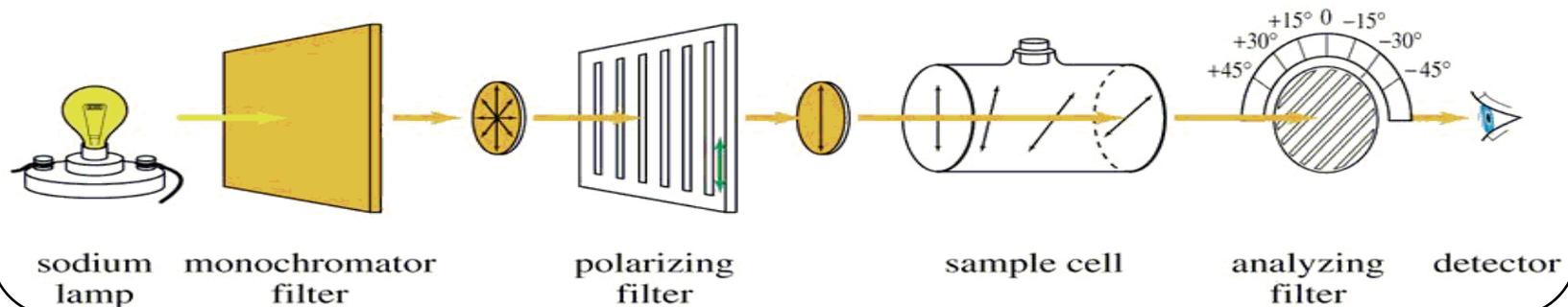
# Physical Characters of Monosaccharides

## Optical Activity

\* Compound having asymmetric carbon can rotate the beam of the plane polarized light and are said to be optically active

■ When plane polarized light passes through a solution containing a **single** chiral compound, the chiral compound causes the plane of vibration to rotate.

### ■ Polarimeter

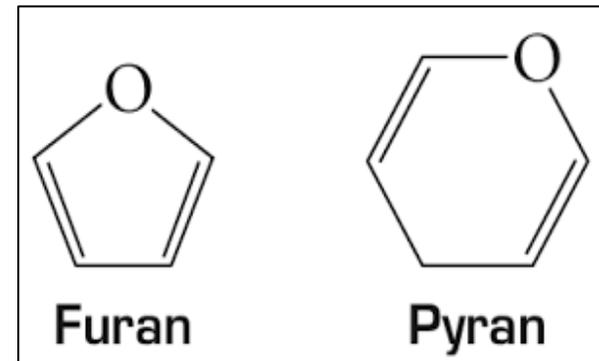


# Physical Characters of Monosaccharides

## 4- Ring structure

\* aldehydes and ketones react with alcohols to form **hemiacetals & hemiketals** respectively

\* Open chain (Fischer Projection) of D-glucose is so reactive that almost all molecules quickly rearrange their bonds to form new structure



# Physical Characters of Monosaccharides

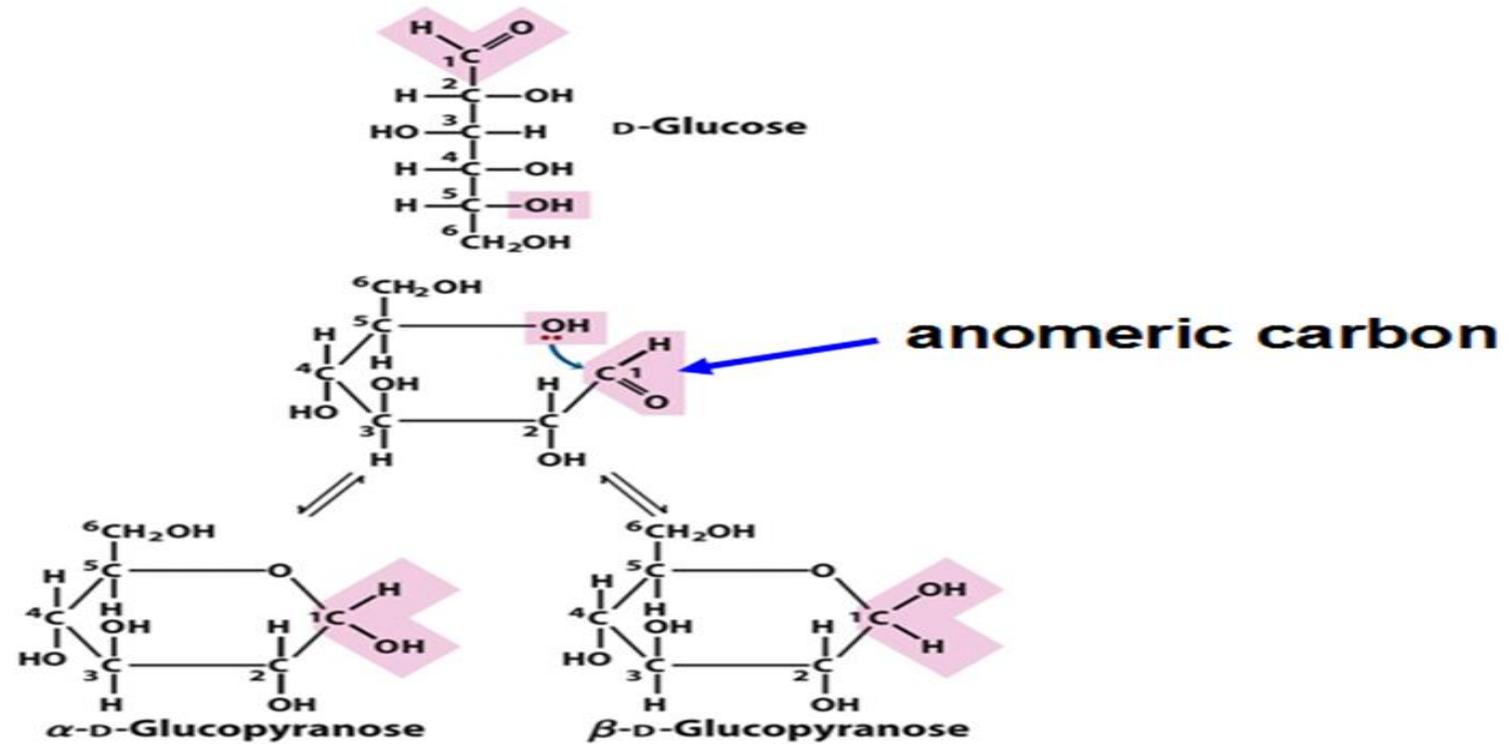
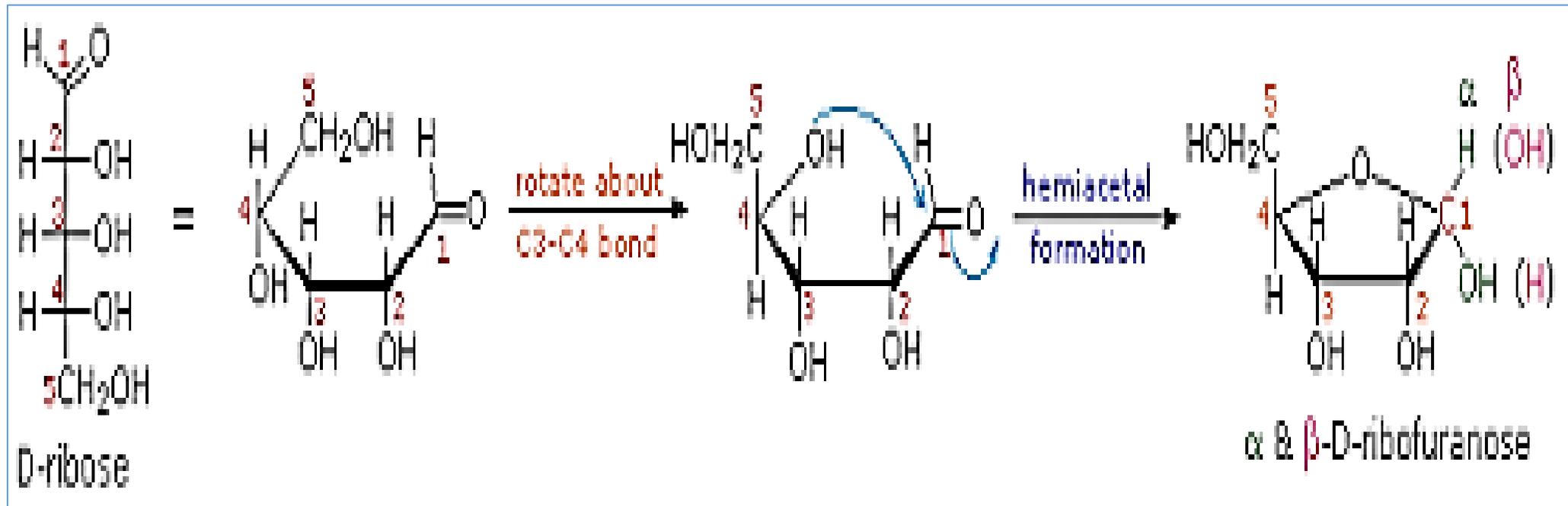
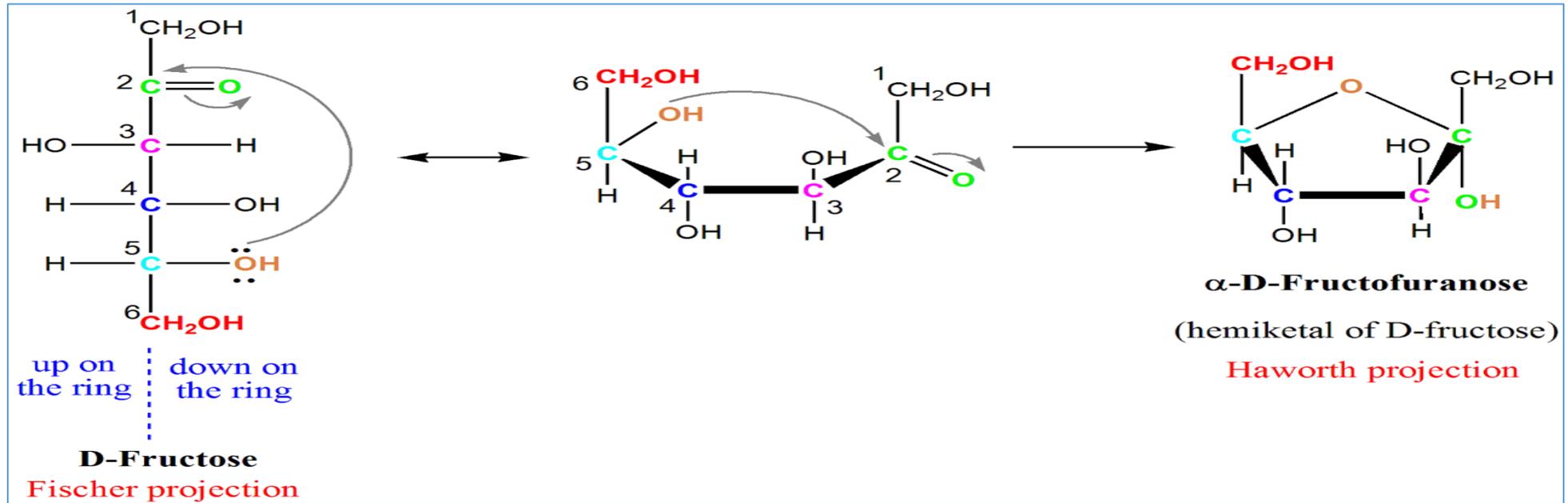


Figure 7-6  
*Lehninger Principles of Biochemistry, Fifth Edition*  
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# Physical Characters of Monosaccharides

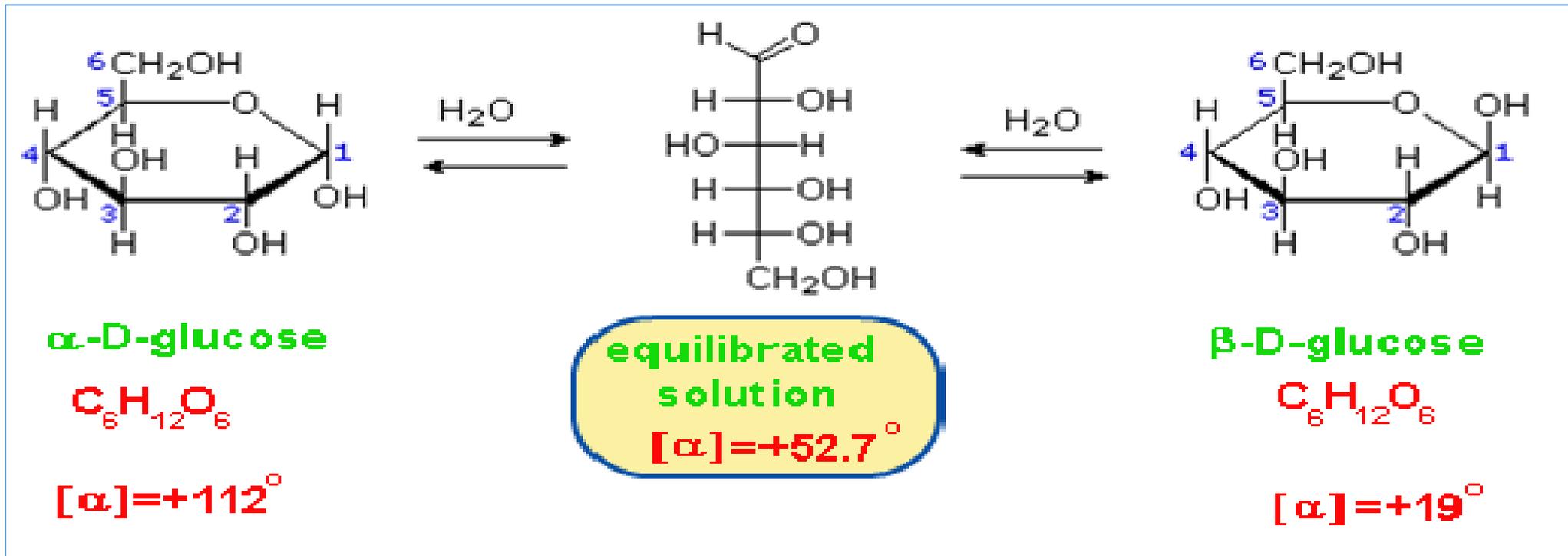


# Physical Characters of Monosaccharides



# Physical Characters of Monosaccharides

## 5- Mutarotation



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# Some important monosaccharides

## 1- Glucose

- \* Glucose is known as *dextrose*, *blood sugar* or *grape sugar*.
- \* It is a component of the disaccharides:
- \* is the monomer of the polysaccharides:
- \* Glucose is carried by the bloodstream to all body parts.
- \* Glucose is found in the urine of those who have diabetes mellitus (sugar diabetes).

glycosuria.

## Glycemic Index

- \* It is a scale that compares the blood sugar response from eating CHO with response evoked by glucose.



Gloved hand holding an intravenous (IV) drip bag containing 0.15% potassium chloride (saline) and 5% glucose.

Chira Pustun & Jacqui Farrer/Kiehl & Photo Library/Photo Research Inc.

# Some important monosaccharides

## 2- Galactose

- Galactose is also an aldohexose
- occurs, along with glucose, in lactose and in many oligo- and polysaccharides
- Galactose is synthesized in the mammary glands to make the lactose of milk.

### Galactosemia

\* infants is born with a genetic defect, that the child unable to utilize the galactose, When the enzyme galactose-1-phosphate uridinyltransferase is defective, however, the disorder is called galactosemia



Charles D. Winans/Karagay Learning

A number of products are available to meet calcium needs of those who are lactose intolerant.

# Some important monosaccharides

## 3- Fructose

- \* Fructose, also known as *levulose*, is a ketohexose that occurs in fruit juices, honey,
- \* and, along with glucose, as a constituent of sucrose.
- Fructose is the major constituent of the polysaccharide

## 4- Ribose

- \* D-ribose & D-2-deoxyribose are most interesting pentoses, because their relationship to nucleic acids (genetic material) & genetic codes
- \* Ribose in RNA (Ribonucleic Acid)
- \* D-2-deoxyribose in DNA (Deoxy Ribonucleic Acid)
- \* It is a constituent of coenzyme A (CoA) and second messenger (cAMP/cyclic adenosine monophosphate)

5- Arabinose and xylose occur in some plants as polysaccharides called pentosans. They are found in grains, fruits, and legumes.

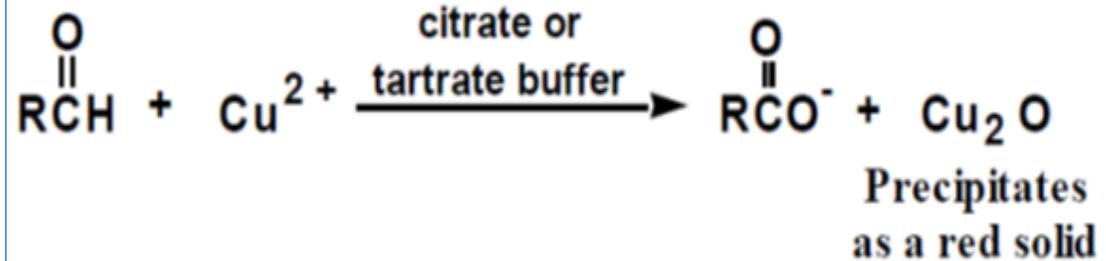
- \* Pentosans are used in the baking industry to increase water holding capacity of the flour in effect slowing down the rate of time it takes the bread to go stale.

# The main chemical reactions of CHO

## 1- Oxidation reactions (Reducing power ability):

Generally all free monosaccharaides have free aldehyde or ketone group are capable of being oxidized. After being oxidized, they cause the reduction of other substances and so known as reducing sugar.

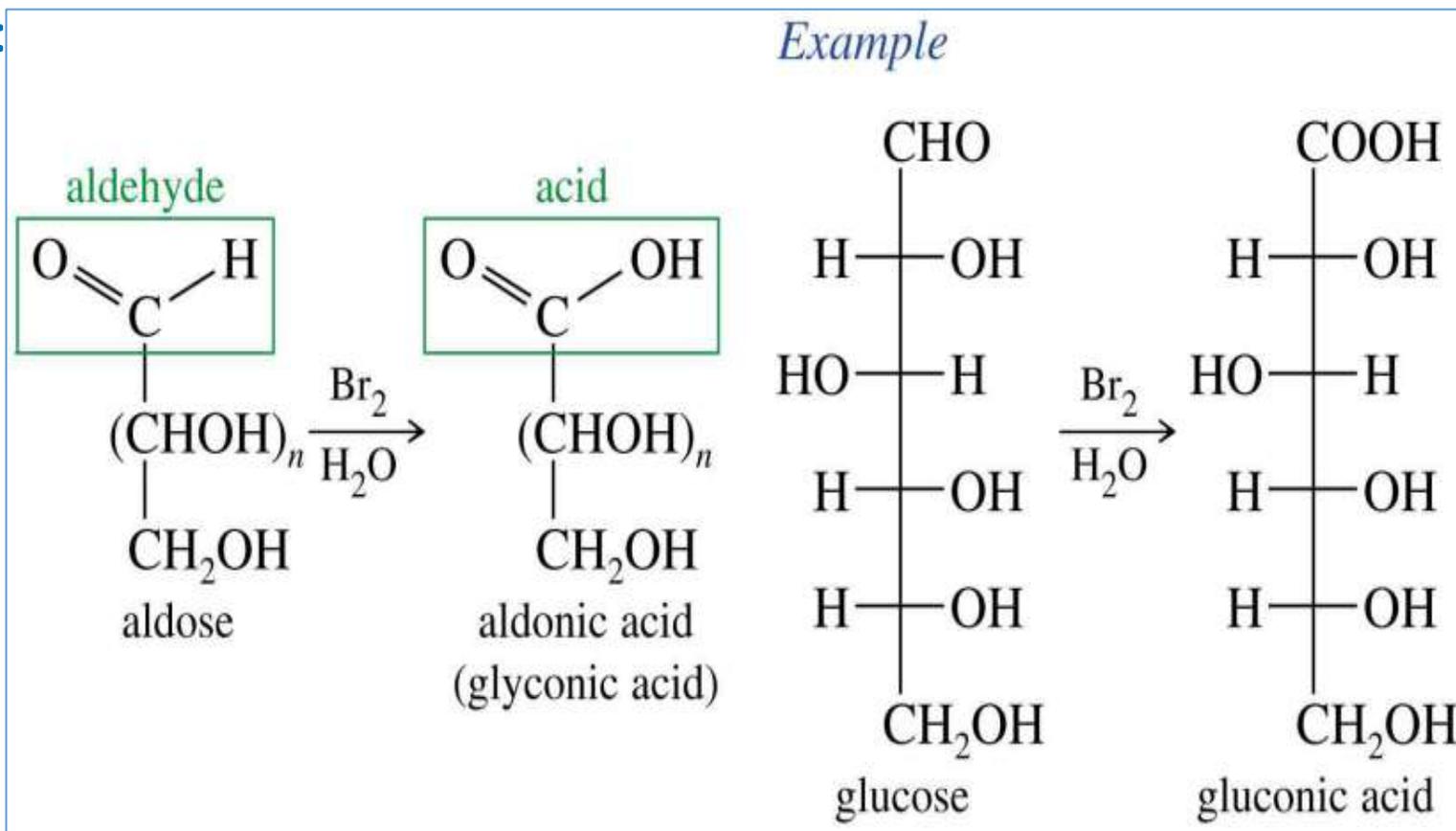
A) Several qualitative tests are used to detect the presence of reducing sugars



# The main chemical reactions of CHO

## B) Oxidation by Bromine:

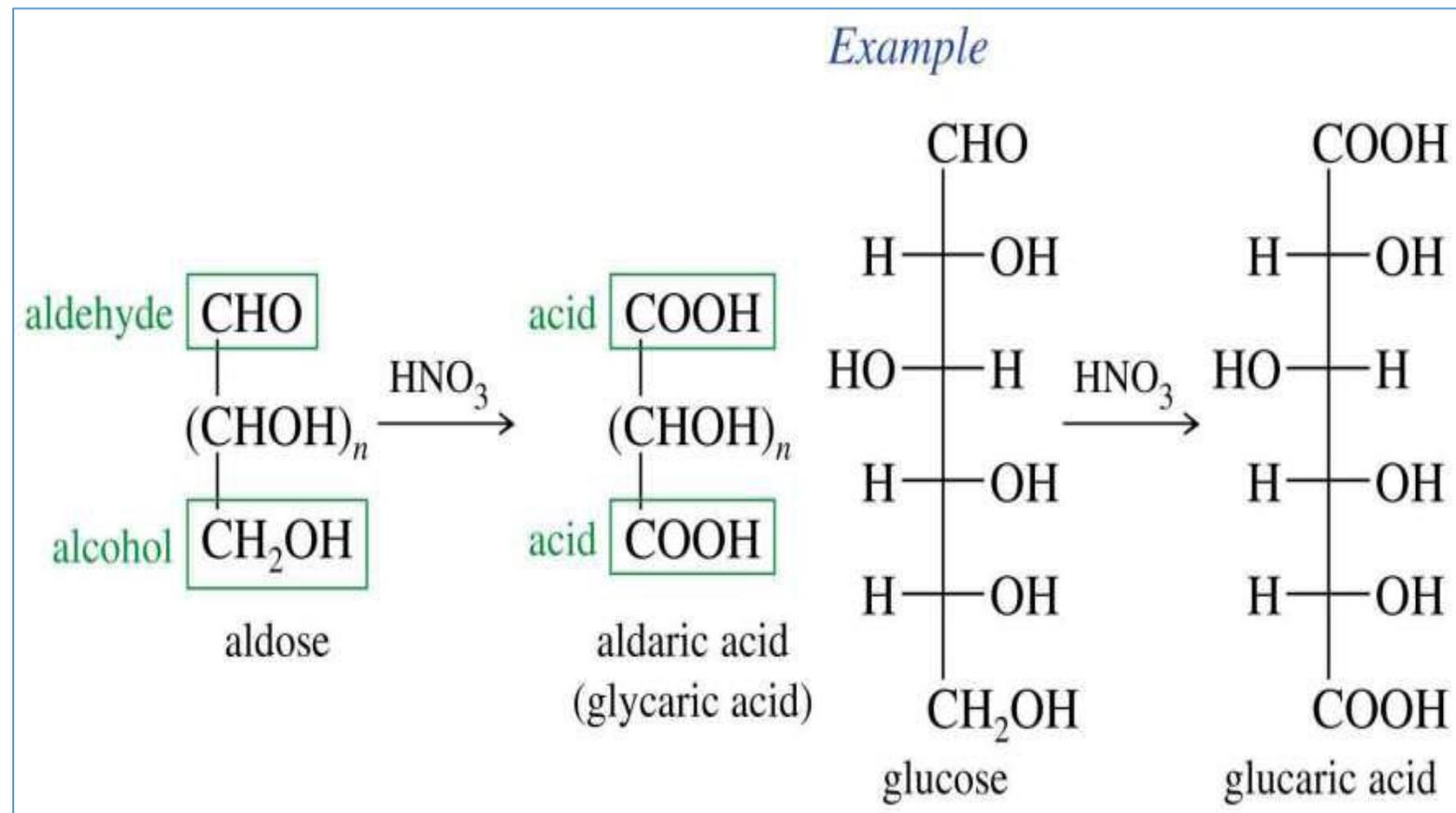
Bromine water oxidizes aldehyde, but not ketone or alcohol.



# The main chemical reactions of CHO

## C) Oxidation by Nitric Acid:

Nitric acid oxidizes both the aldehyde and the terminal alcohol.



Chemstrip kit for blood glucose.

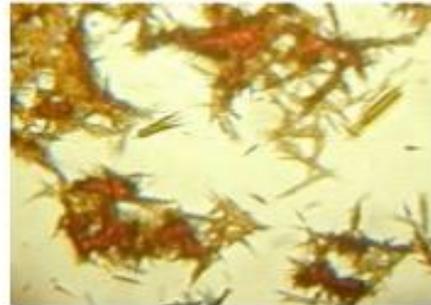
# The main chemical reactions of CHO

## D) Osazone formation:

Phenylhydrazine in acetic acid, when boiled with reducing sugars, forms osazones. Both C1 and C2 react with phenylhydrazine.



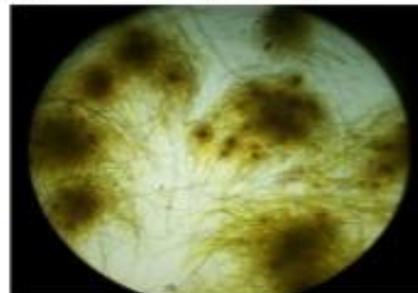
Needle shaped glucosazone crystals as viewed under the microscope



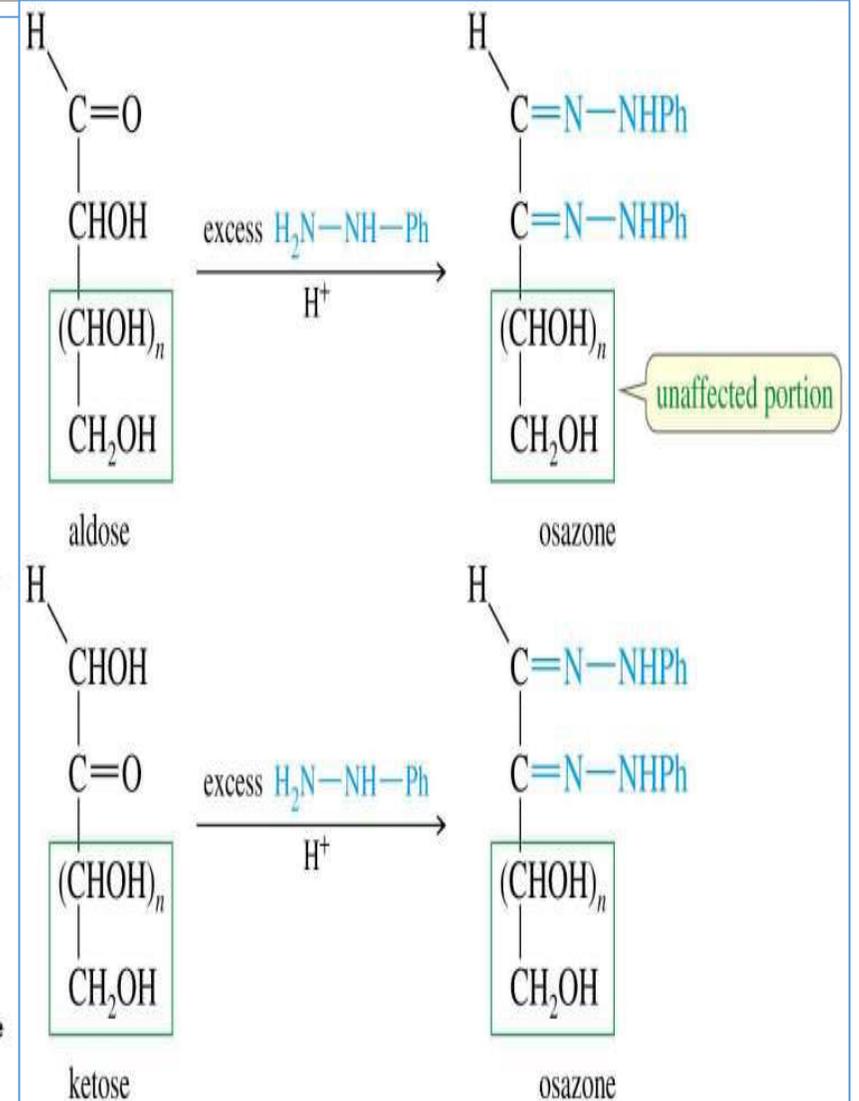
Galactosazone crystals as viewed under the microscope (Rhombic plates)



Sun flower shaped Maltosazone crystals as viewed under the microscope



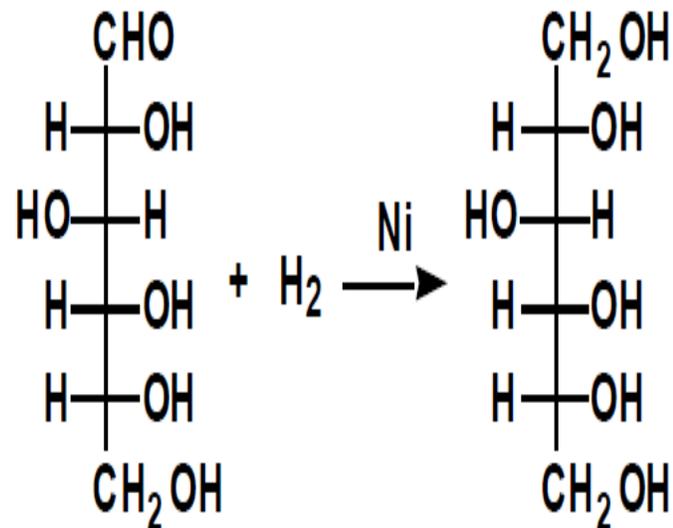
Powder puff/hedge hog shaped crystals of lactose as viewed under the microscope



# The main chemical reactions of CHO

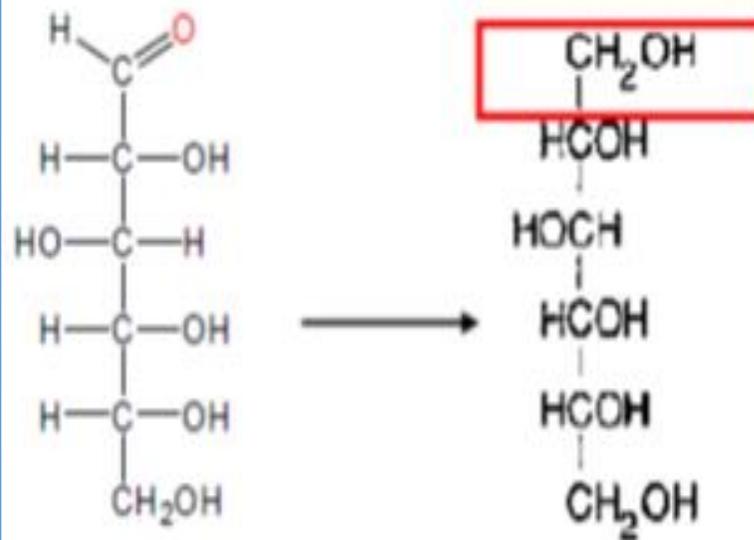
## 2- Reduction to alditols:

The carbonyl group of a monosaccharide can be reduced to hydroxyl group by a variety of reducing agents, including NaBH<sub>4</sub> and H<sub>2</sub>/Ni.



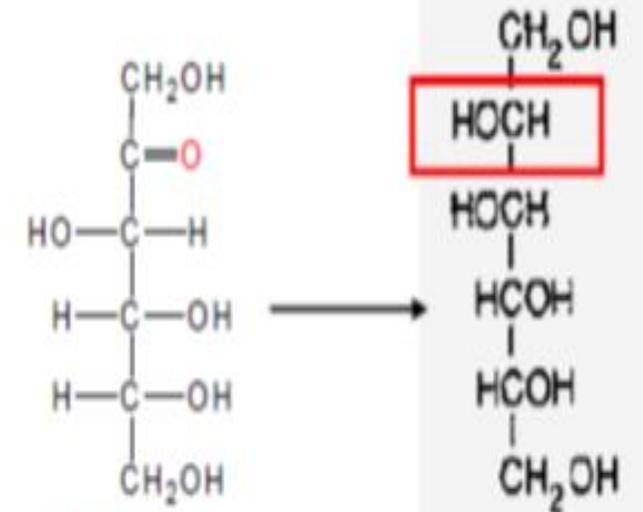
D-Glucose

D-Glucitol  
(D-Sorbitol)



D-glucose

D-Sorbitol



D-fructose

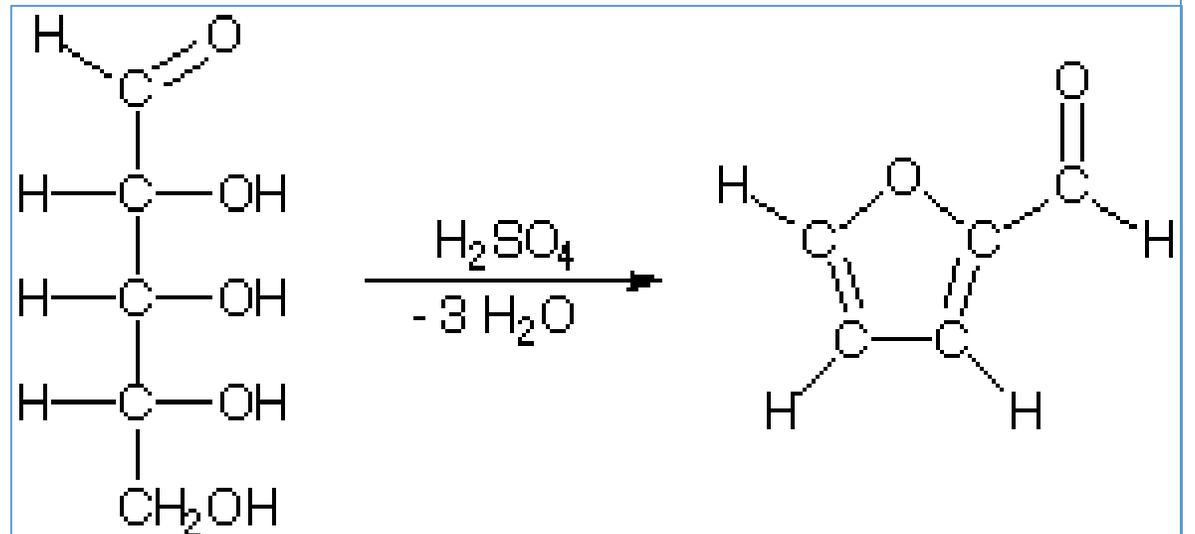
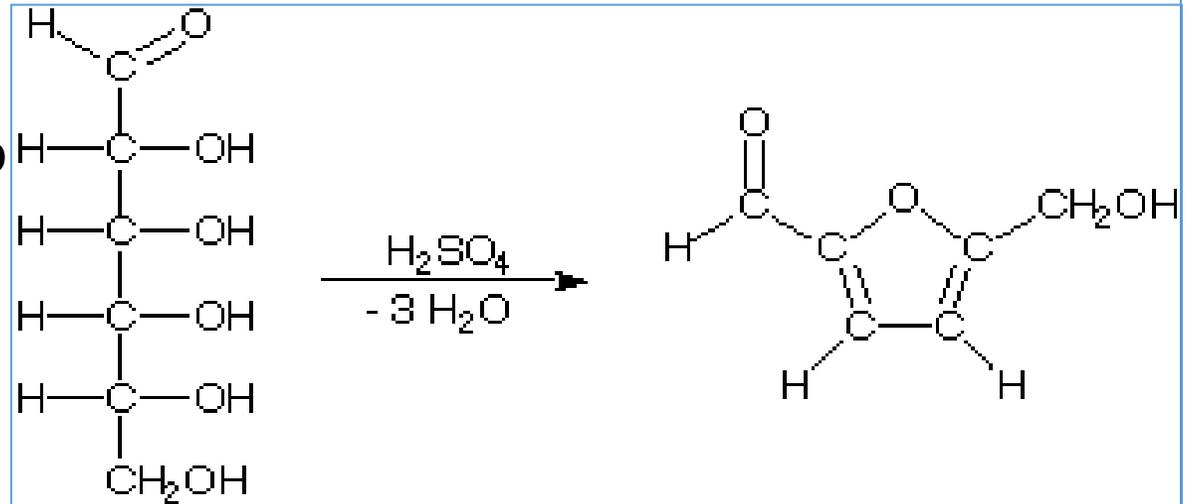
D-Mannitol

# The main chemical reactions of CHO

## 3- Dehydration:

\* The test reagent dehydrates pentoses to form furfural and dehydrates hexoses to form 5-hydroxymethyl furfural.

\* The furfurals further react with  $\alpha$ -naphthol present in the test reagent to produce a purple product



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# Sugar Derivatives

```
graph TD; A[Sugar Derivatives] --> B[Deoxy sugar]; A --> C[Sugar phosphate]; A --> D[Sugar alcohol]; A --> E[Amino sugar]; A --> F[Acidic sugar]; A --> G[Glycosides];
```

**Deoxy  
sugar**

**Sugar  
phosphate**

**Sugar  
alcohol**

**Amino sugar**

**Acidic  
sugar**

**Glycosides**

# Sugar Derivatives

## Deoxy sugar

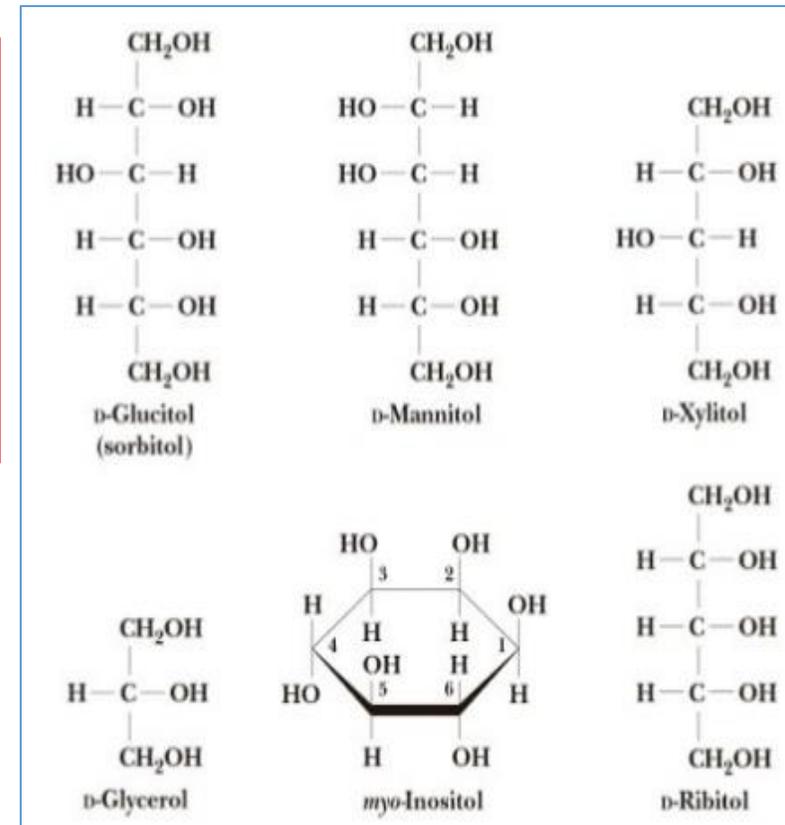
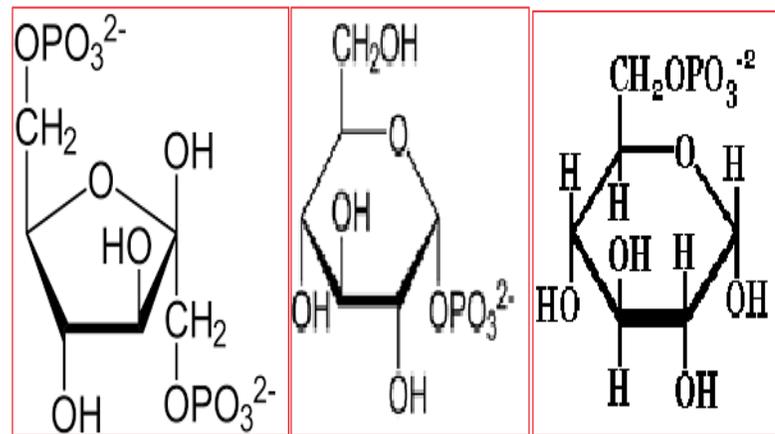
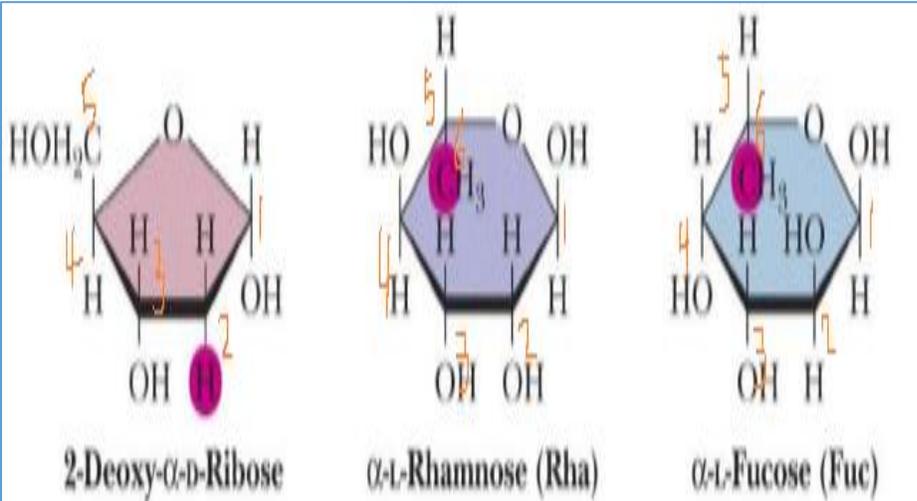
\* Deoxy ribose \* Fucose \* Rhamnose

## Sugar phosphate

\* G-1-P \* F-1,6-P \* G-6-P

## Sugar alcohol

\* Sorbitol \* Glycerol  
\* Galactitol \* mannitol



# Sugar Derivatives

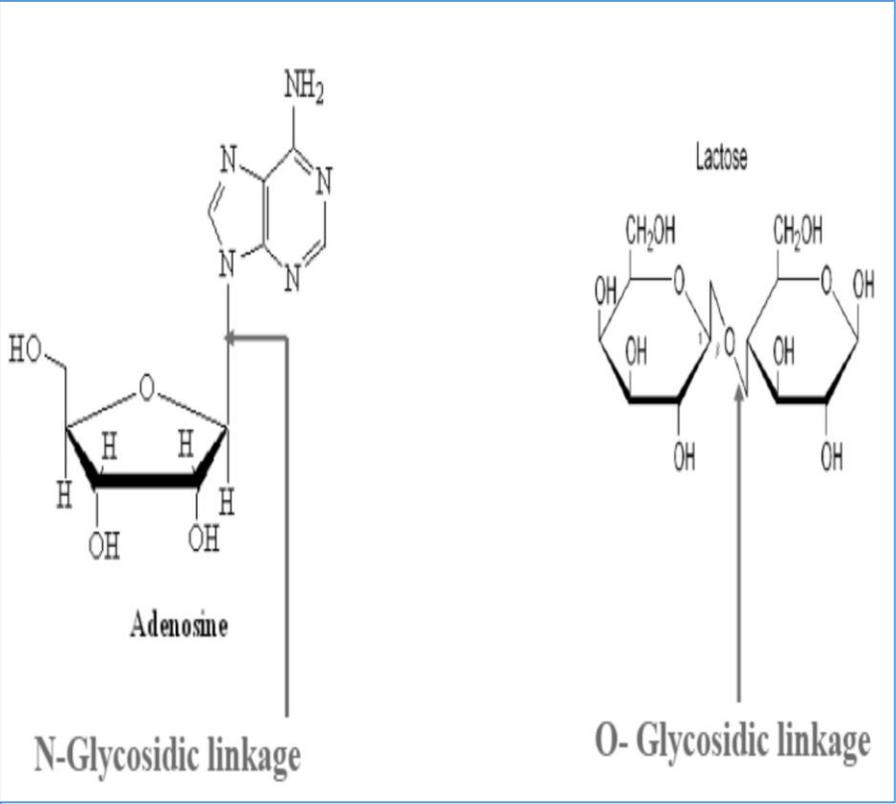
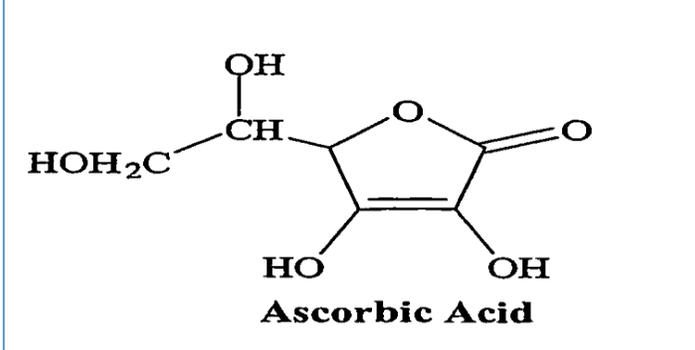
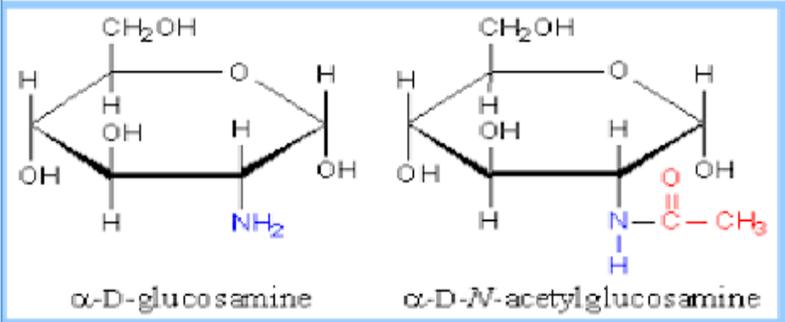
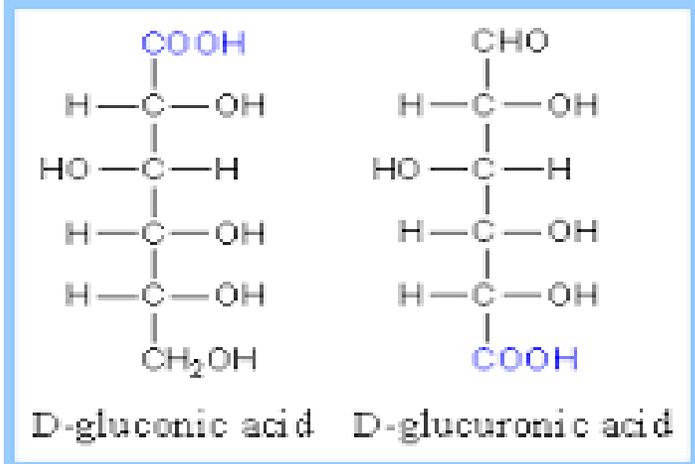
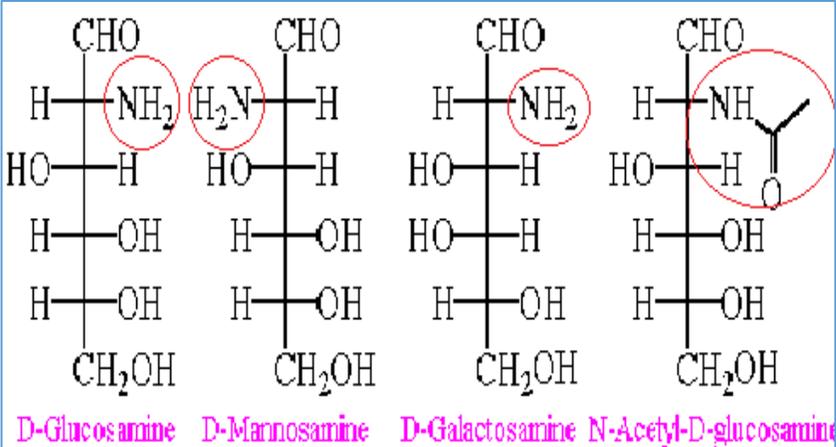
**Amino sugar**

- \* Galactose amine \* Glucose amine
- \* N-acetyl-glucose amine \* Sialic acid

**Acidic sugar**

- \* Gluconic acid \* Glucouronic acid
- \* Ascorbic acid

**Glycosides**



# Oligosaccharides

\* Consist of (2-10) monomers (monosaccharides) \* Combine by O-glycosidic bond

## Disaccharides

\* Consist of 2 monosaccharides

### Important disaccharides

Lactose

Maltose

Sucrose

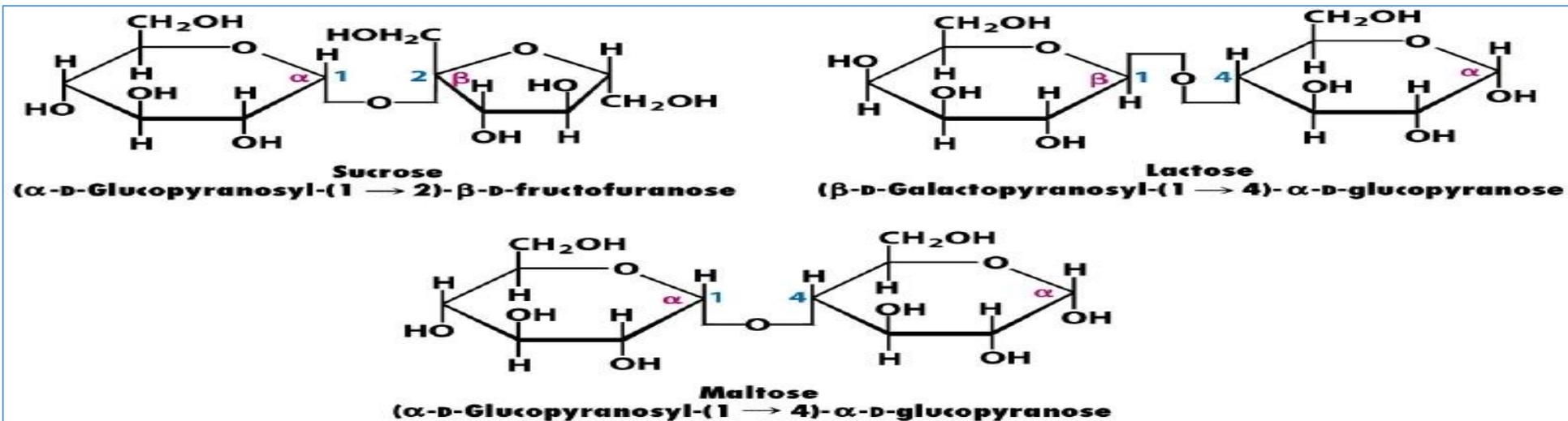
### Uncommon disaccharides

- Isomaltose in glycogen & amylopectin
- Cellobiose in cellulose
- Terhalose in insect hemo lymph

## Other oligosaccharides

\* Consist of more than 2 monosaccharides

- **Raffinose** (trisaccharides) which found peas & beans. (Gala+G+F)
- **Stachyose & verbascose** (tetra saccharides), which found in soya bean. (2 Gala+G+F)



# Oligosaccharides

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\* Consist of 2 monosaccharides

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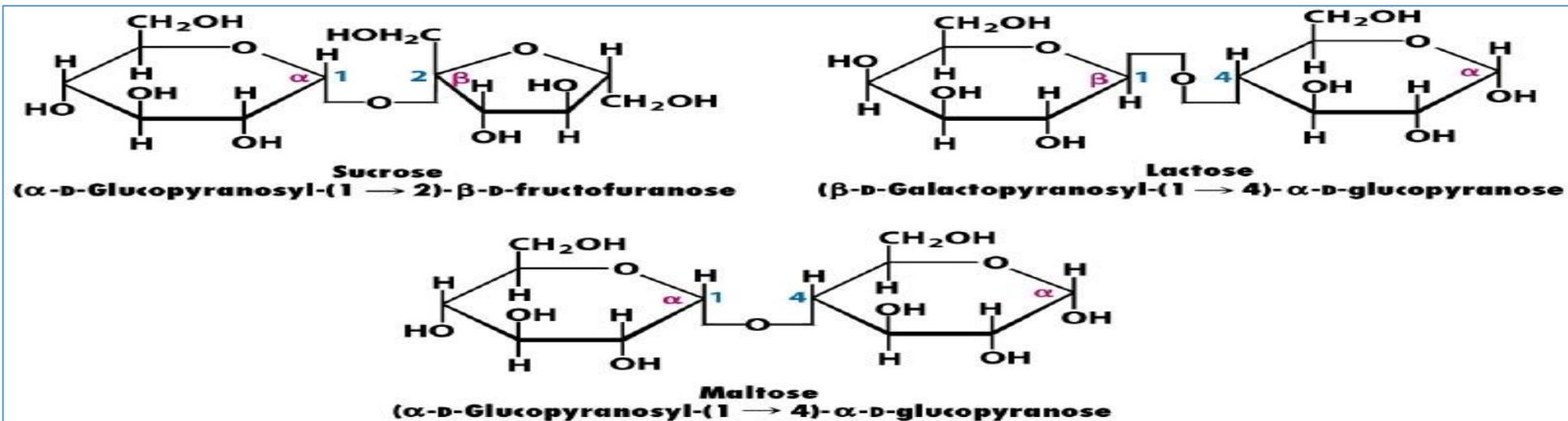
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## Other oligosaccharides

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# Polysaccharides

## Homopolysaccharides (Homoglycan)

\* They made up from one type of monosaccharides

## Heteropolysaccharides

(Mucopolysaccharides, Glycoaminoglycan)

\* They made up from different types of monosaccharides besides other chemical compounds

Starch

Glycogen

Cellulose

Dextran

Inulin

Agar

Chitin

# Homopolysaccharides

## Starch \*( $\alpha$ -D-glucose)

\* Amylose  $\alpha(1\rightarrow4)$

\* Amylopectin  $\alpha(1\rightarrow4)$  &  $\alpha(1\rightarrow6)$

## Glycogen \*( $\alpha$ -D-glucose)

\* Amylopectin

\* More branched

## Cellulose \*( $\beta$ -D-glucose)

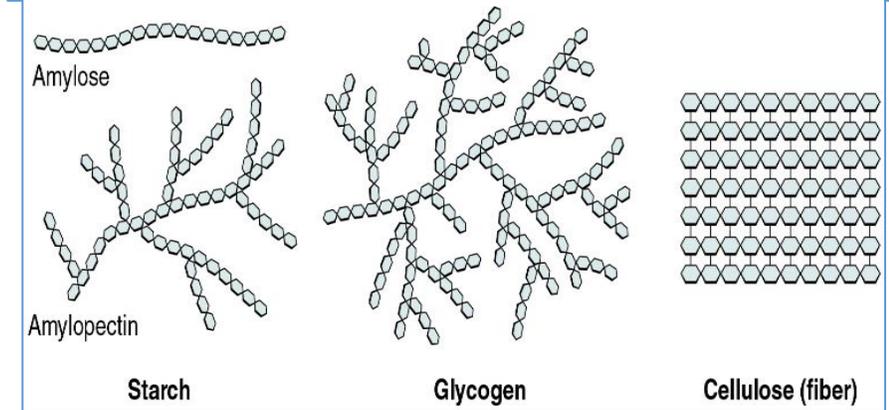
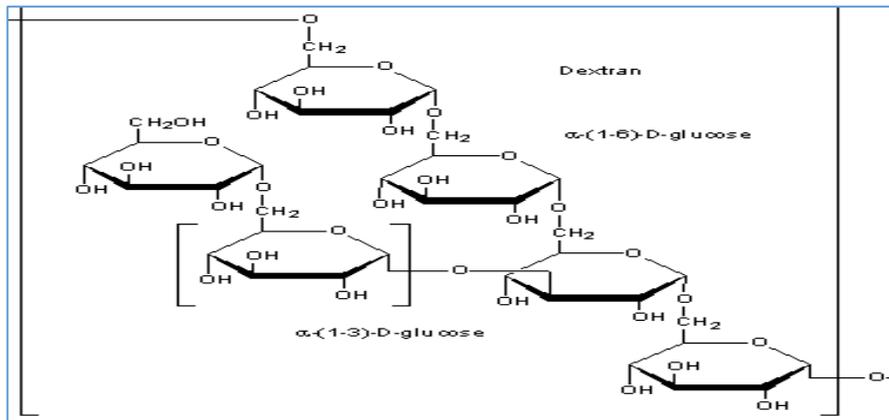
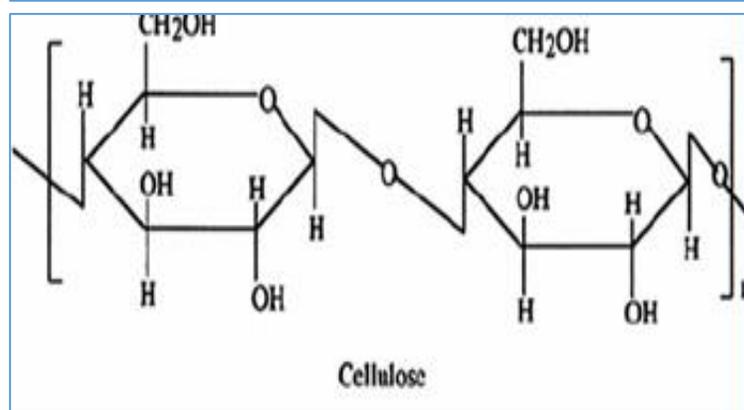
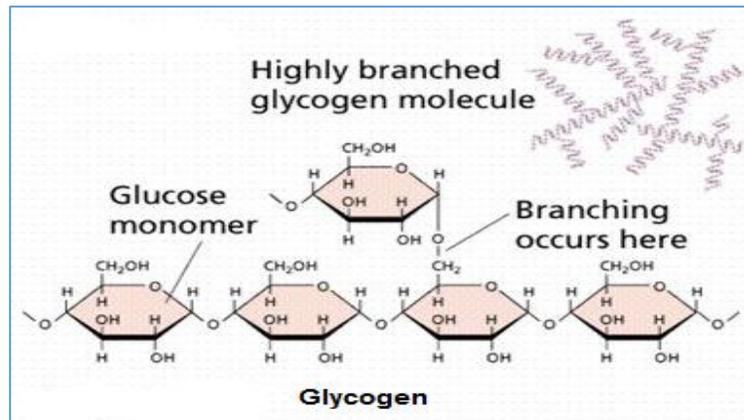
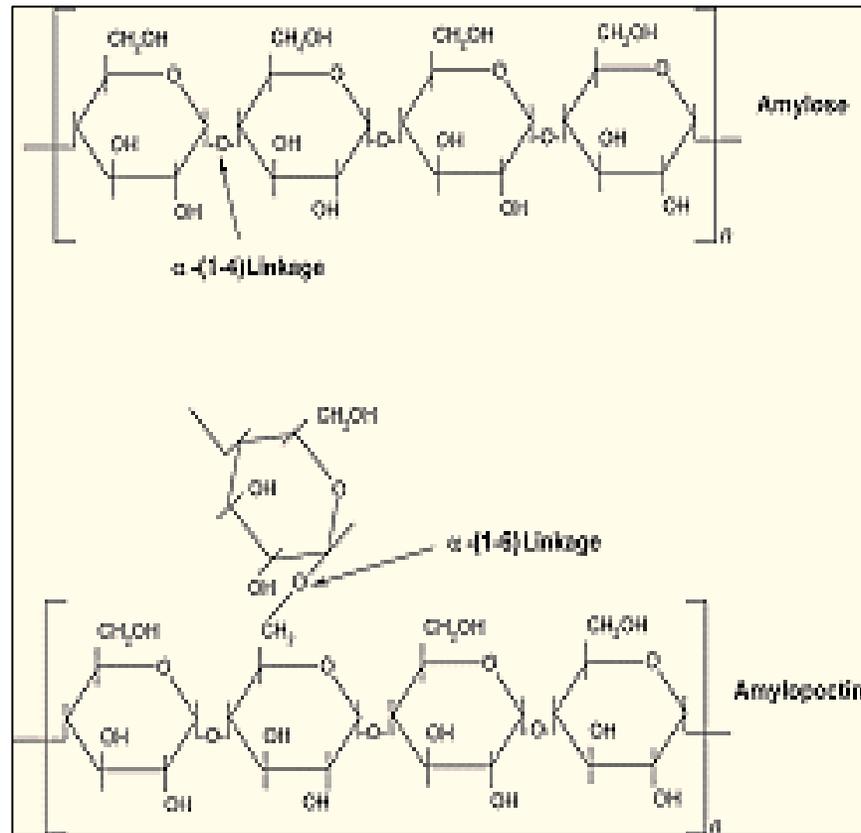
\* Linear  $\beta(1\rightarrow4)$

\* unbranched

## Dextran \*( $\alpha$ -D-glucose)

\*  $\alpha(1\rightarrow6)$  &  $\alpha(1\rightarrow3)$

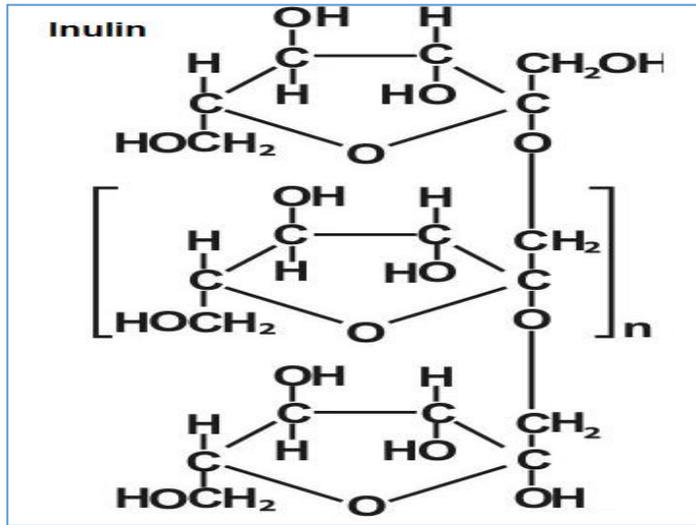
\* used as plasma substitute



# Homopolysaccharides

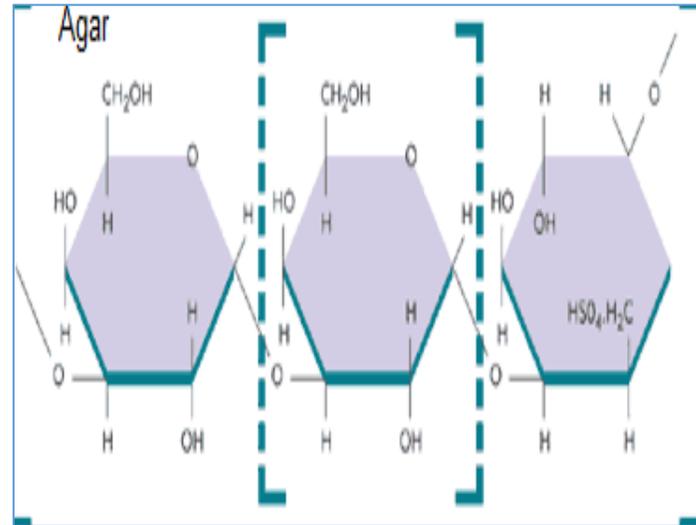
Inulin

( $\beta$ -D-fructose)



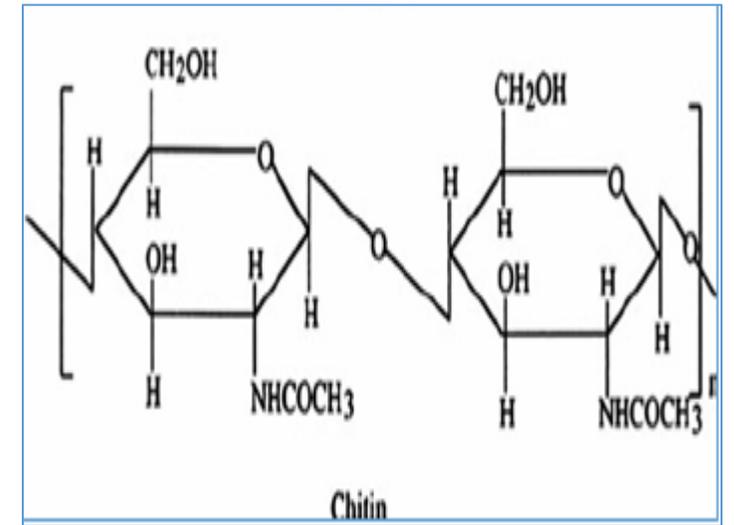
Agar

(sulphate galactose)



Chitin

(N-acetyl glucosamine)



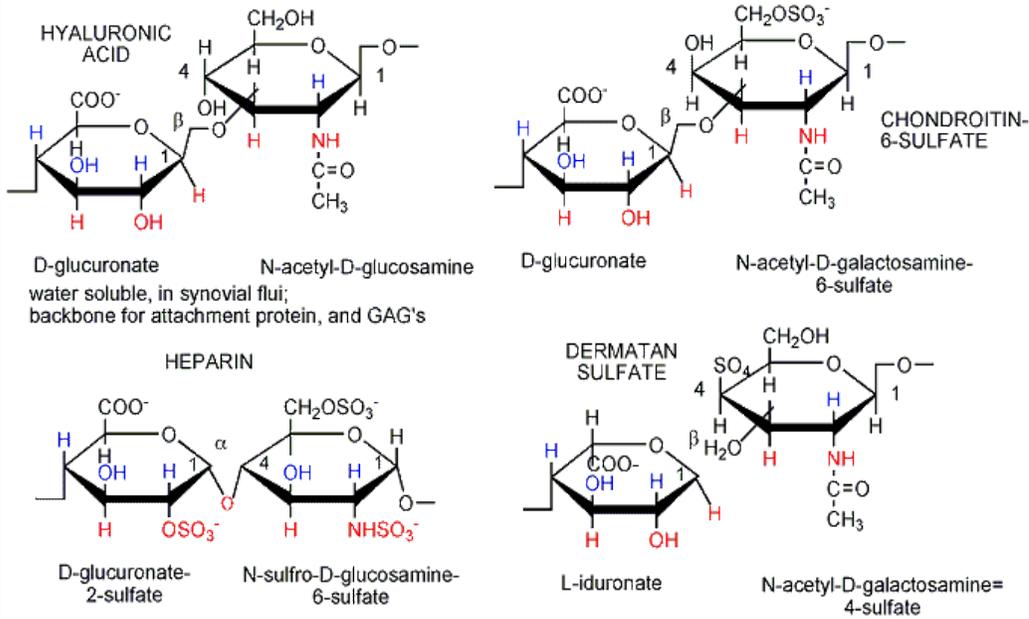
# Polysaccharides

## Homopolysaccharides

## Heteropolysaccharides (Mucopolysaccharides, Glycoaminoglycan)

\* They made up from different types of monosaccharides besides other chemical compounds

**GLYCOSAMINOGLYCANS (GAG)** acid polysacch., form matrix to hold protein component of skin, connect. tissue, extracellular matrix.

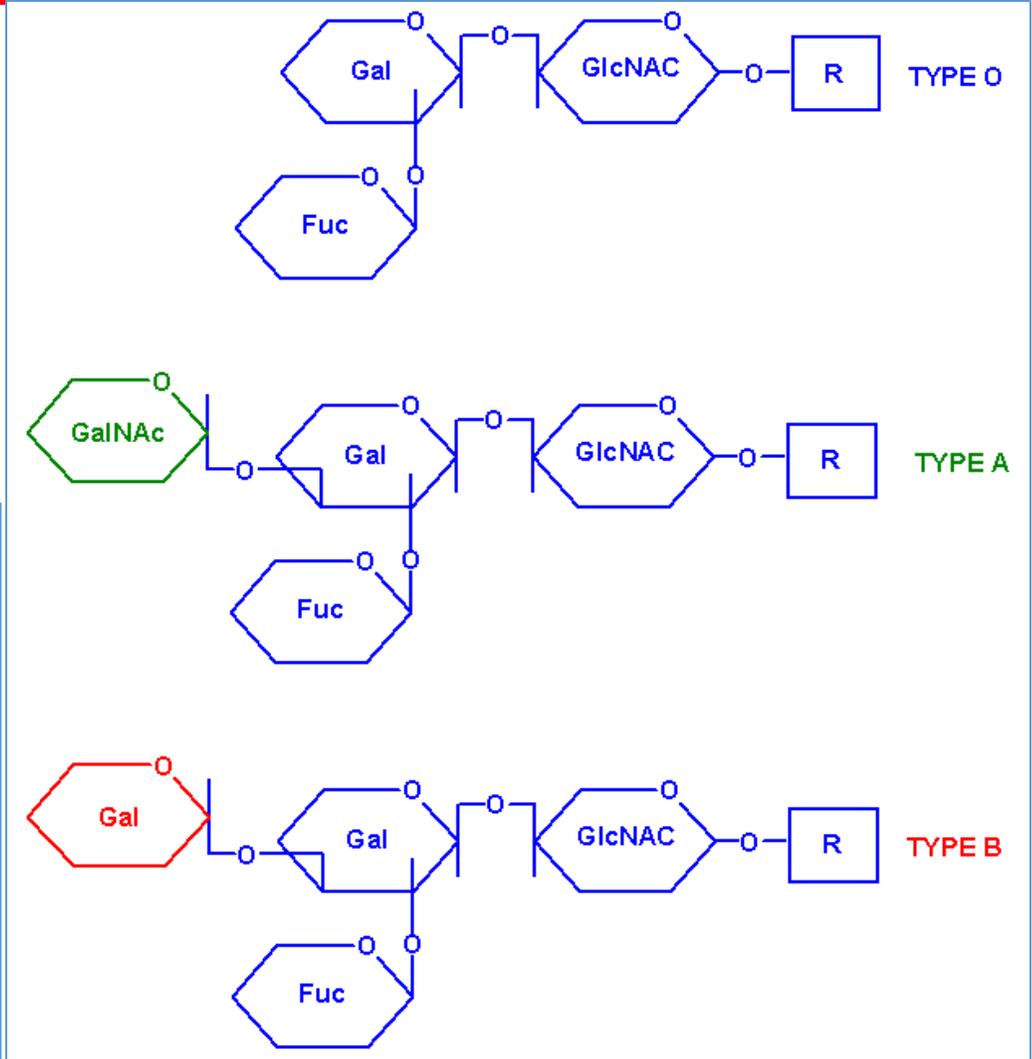
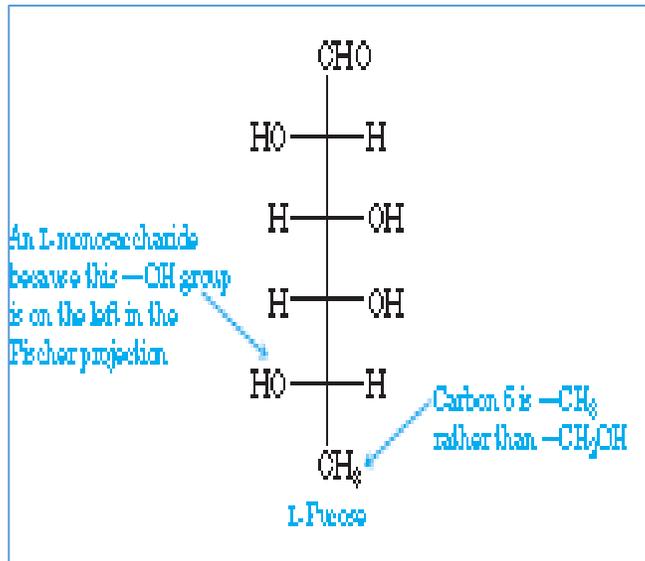


Mucopolysaccharides	Composition	Importance
1. Hyaluronic acid	D-glucuronic acid N-acetyl-D-glucosamine	Occurs in synovial fluids, vitreous humor of the eye & lubricating fluid of joints.
2. Chondroitin sulphate	D-glucuronic acid N-acetyl-D-glucosamine sulphate	Component of cartilage tendons & skin( connective tissues)
3. Dermatan sulphate	L-iduronic acid N-acetyl-D-glucosamine sulphate	Component of cartilage tendons & skin( connective tissues)
4. Keratan sulphate	D-galactose N-acetyl-D-glucosamine sulphate	Component of cartilage & cornea
5. Heparin sulphate	D-iduronic acid (sulphated) N-acetyl-D-glucosamine sulphate	Present in most cells especially in liver, lungs & arterial walls.

# Blood group substances

\* Typically, they contain from 4 to 17 monosaccharide units consisting primarily of relatively few monosaccharides, the most common of which are: D-galactose, D-mannose, L-fucose, *N*-acetyl-D-glucosamine, and *N*-acetyl-D-galactosamine.

\* L-Fucose is a 6-deoxyaldohexose.



# Screening for Cancer: Finding a Needle in a Haystack

Cancer cells, like other cells, carry specific coded information on their surfaces (carbohydrate antigens) that are released into the blood. Ideally, this release can provide advance warning that a hidden cancer is growing. Furthermore, knowing the identity of the carbohydrate can point toward the tissue in which the cancer may be hiding. Scientists have identified a number of different carbohydrate antigens (CA) associated with cancer: CA 15-3 for breast cancer; CA 19-9 for pancreatic cancer; PSA, EPCA-2.22, and EPCA- 2.19 for prostate cancer; and CA 125 and HE-4 for cervical cancer. Unfortunately, each of these antigens is not *absolutely* specific for one cancer. So, a high level of one of these antigens in the blood could signal cancer but also could signal something else.

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General Biochemistry (1)  
3<sup>rd</sup> class

By

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# Lipids

- **Biological roles of Lipids**
- **Occurrence**
- **Definition**
- **Nomenclature of Lipids**
- **Classification**

# Importance of Lipids

1. They serve as thermal insulator against cold (Fat under skin ).
2. Fat serve as a source of energy for man like carbohydrates.
3. Fat is an ideal form for storing energy in the human body compared to carbohydrates and proteins.
4. Lipids are structural components of cell membrane and nervous tissue.
5. Some lipids serve as precursors for the synthesis of complex molecules. For example, acetyl-CoA is used for the synthesis of cholesterol.
6. Lipoproteins, which are complexes of lipids and proteins are involved in the transport of lipids in the blood and components of cell membrane.  
of lipids in the blood and components of cell membrane.
7. Some lipids serve as hormones and fat soluble vitamins are lipids.
8. Fats are essential for the absorption of fat soluble vitamins.
9. Fats serve as surfactants by reducing surface tension.
10. Lipids also serve as anti-cancer

# Occurrence

- Lipids are present in humans, animals, plants and micro-organisms to some extent.
- fat, egg yolk, butter and cheese are lipids of animal origin, vegetable or cooking oils and vanaspati are lipids from plant origin.

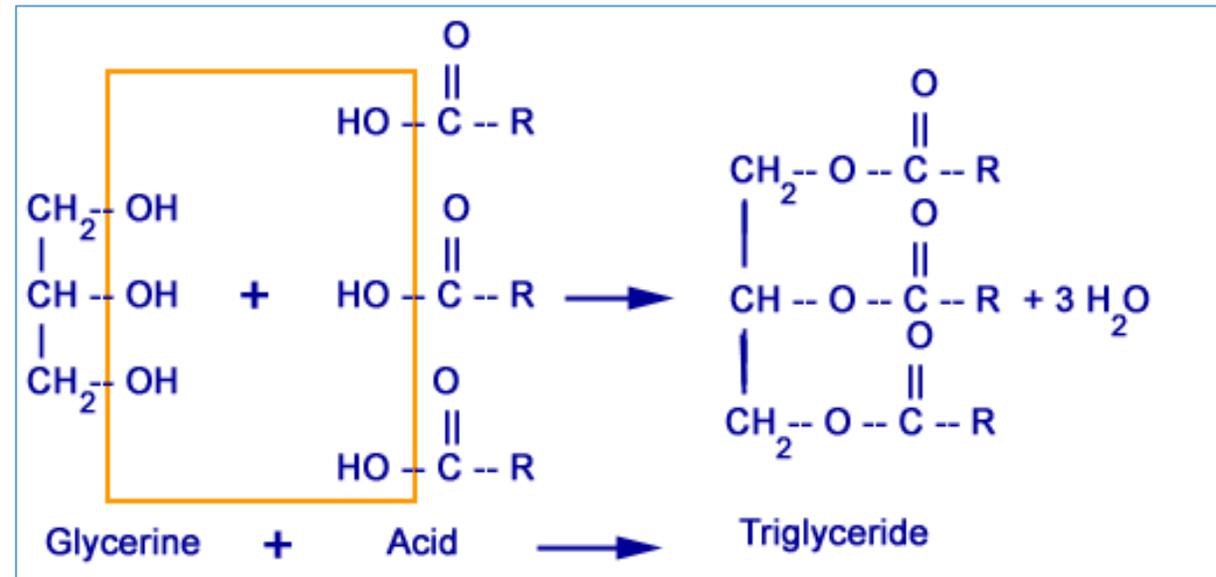
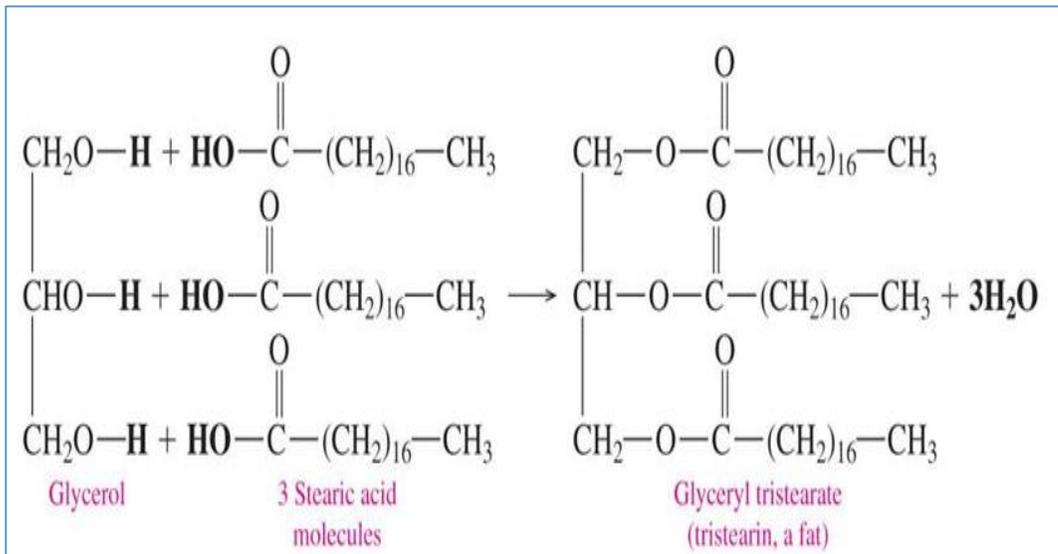
# Definition of Lipids

## Chemically

- \* Esters of alcohol

## Generally

- \* Heterogenous group of compounds
- \* Insoluble in water
- \* Hydrophobic in nature

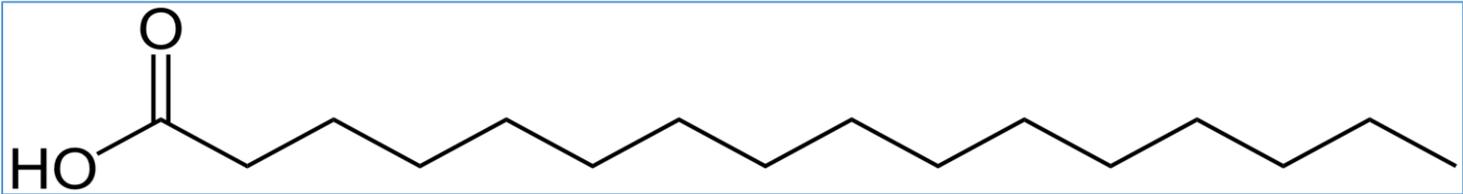
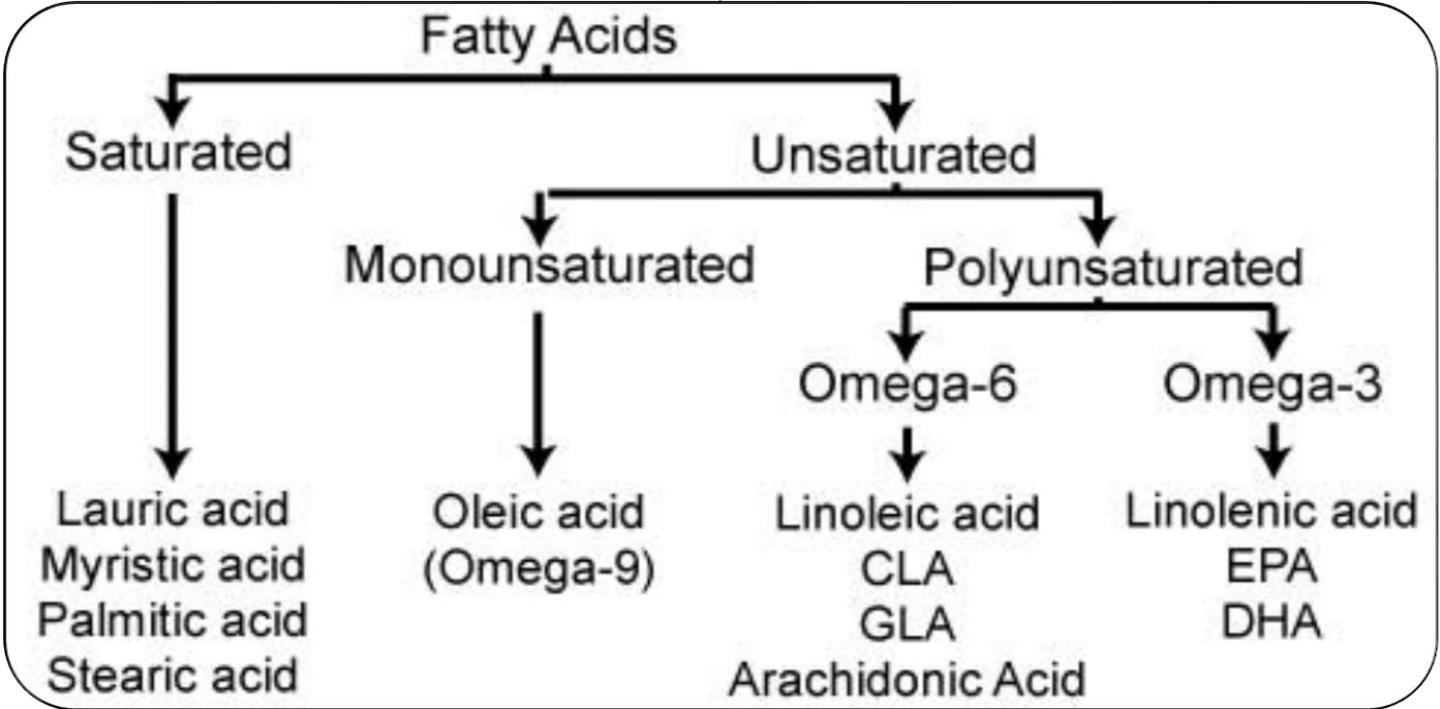


Esters of alcohol

Alcohols

- Unsaturated**
- \* Chlorophyl II
  - \* Lycophyl

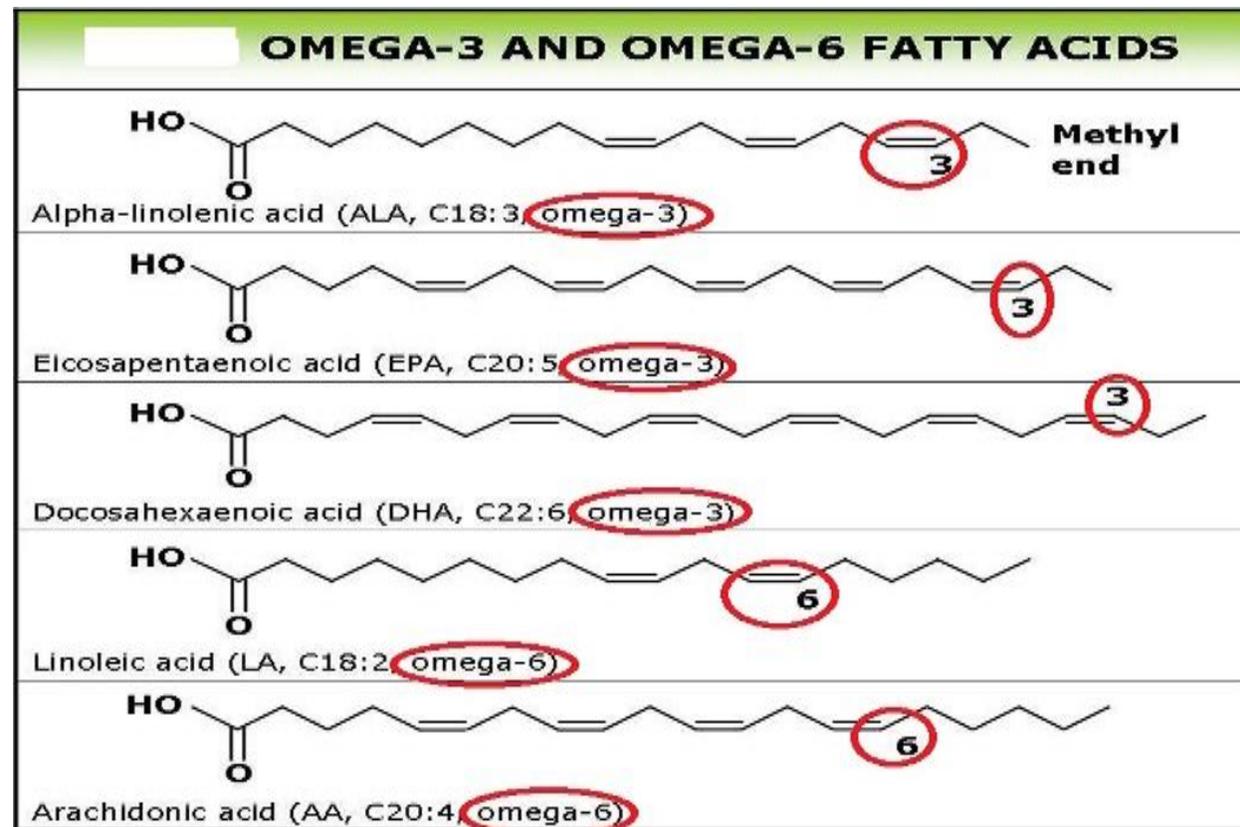
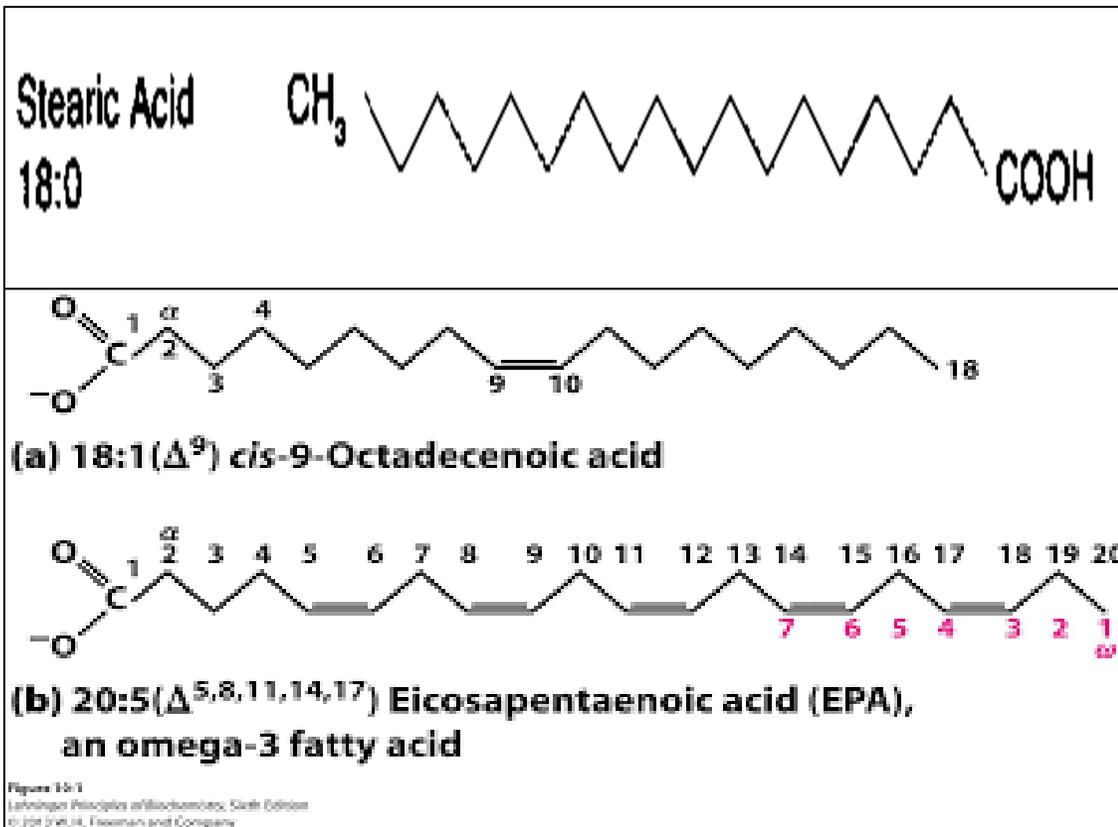
- Saturated**
- \* Glycerol
  - \* Cetyl alcohol
  - \* Myricyl alcohol



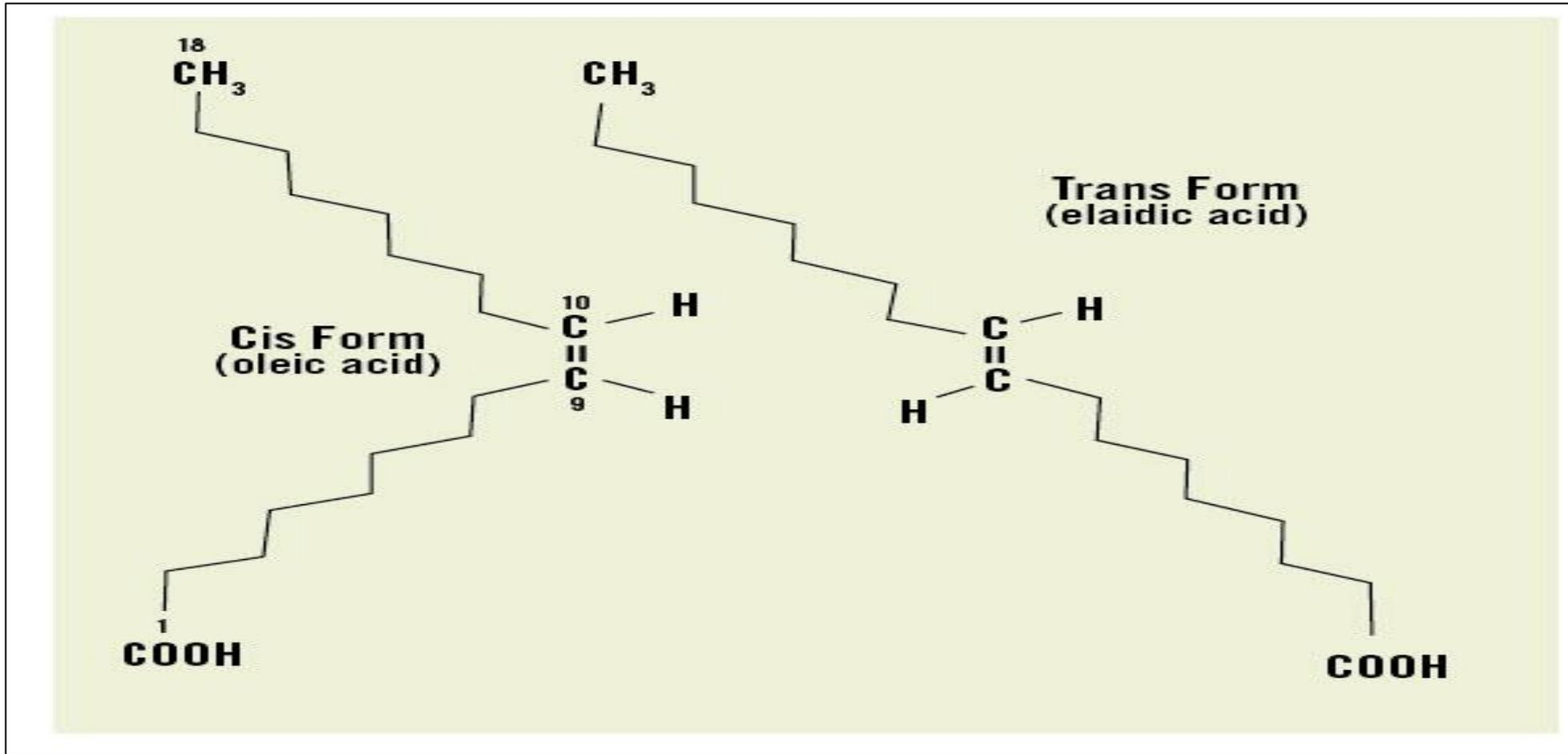
# Nomenclature of Lipids Delta ( $\Delta$ ) & Omega ( $\omega$ ) systems

Saturated SAFA

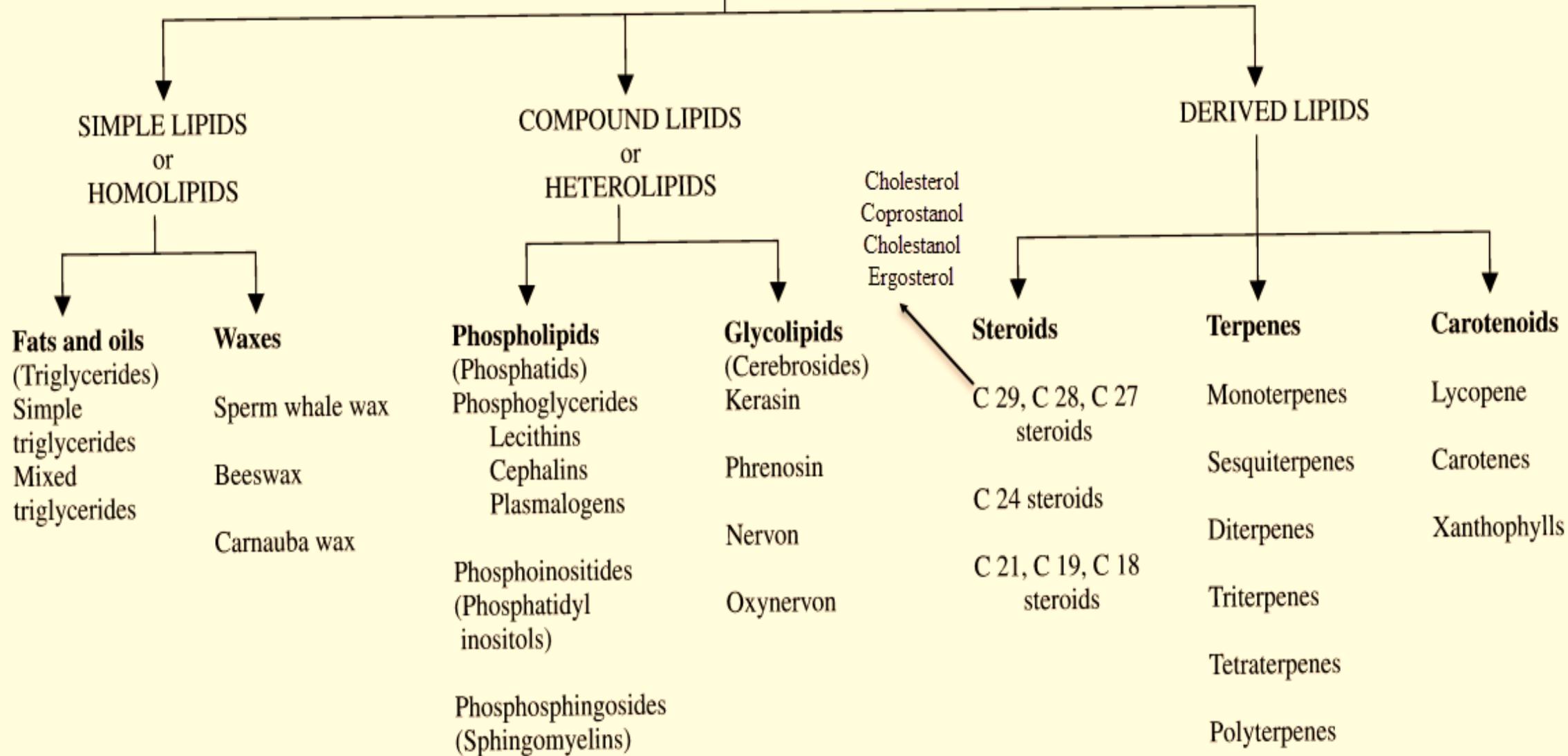
Unsaturated MUFA, PUFA, HUFA



# Geometric Isomerization



# LIPIDS



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# Simple lipids

## Neutral Fats & Oils

- \* They are esters of glycerol with three fatty acids, example Triglycerides (TG)
- \* They are non-polar (hydrophobic)
- \* Usually fats come from animal sources and contain more SAFA
- \* Oils come from plant sources and contain more USFA
- \* Fats--- large proportion of SAFA----High m.p.----solid state
- \* Oils--- large proportion of USFA-----low m.p.----Liquid state

## Waxes

- \* They are esters of long chain FA (C14-C36) with long chain monohydroxy alcohol (C16-C36)
- \* Secreted by cutaneous gland in human
- \* Secreted by preen gland in birds
- \* They served as fuel storage form (plankton)
- \* Exp: Myricyl palmitate ----- Bees waxes  
Cetyl palmitate ----- Sperm whale waxes  
Hexacosanyl palmitate ----- Epicuticular waxes  
Myicyl Cerotate ----- Carnauba waxes

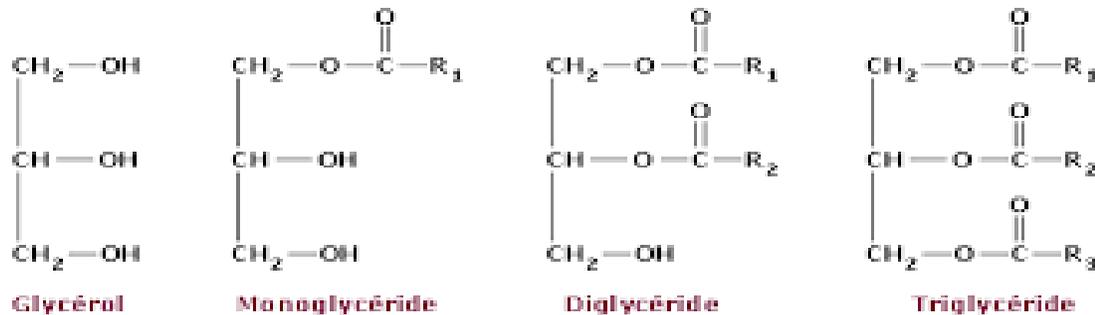


Figure 4 : Glycérides



# Compound lipids

**Phospholipids**

**Glycolipids**

**Phosphoglycerides**

**Phosphoinositides**

**Phosphosphingosides**

# Compound lipids

Phospholipids

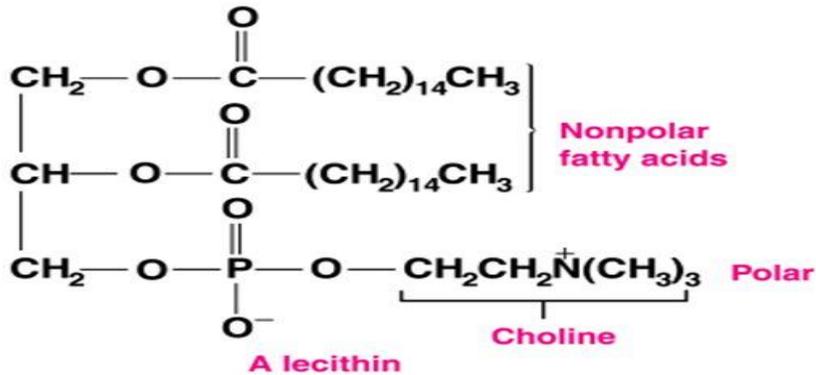
Glycolipids

Phosphoglycerides

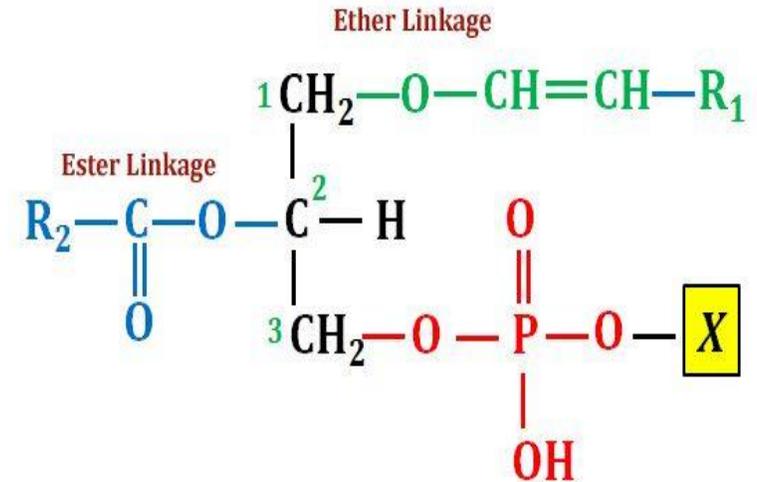
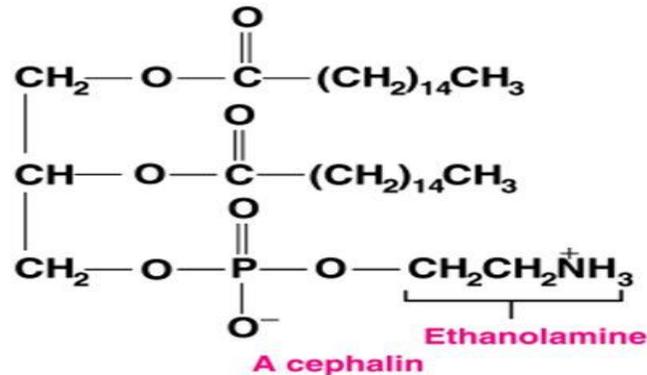
Phosphoinositides

Phosphosphingosides

## Glycerophospholipids (phosphoglycerides)



Timberlake, *General, Organic, and Biological Chemistry*. Copyright © Pearson Education Inc., publishing as Benjamin Cummings



Plasmalogen Backbone

# Compound lipids

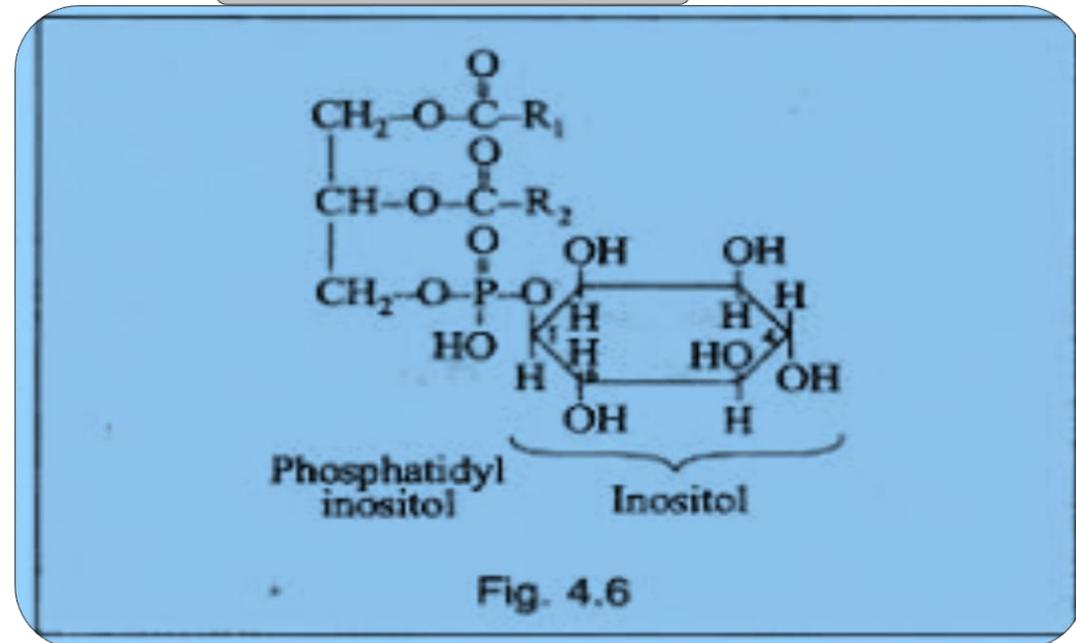
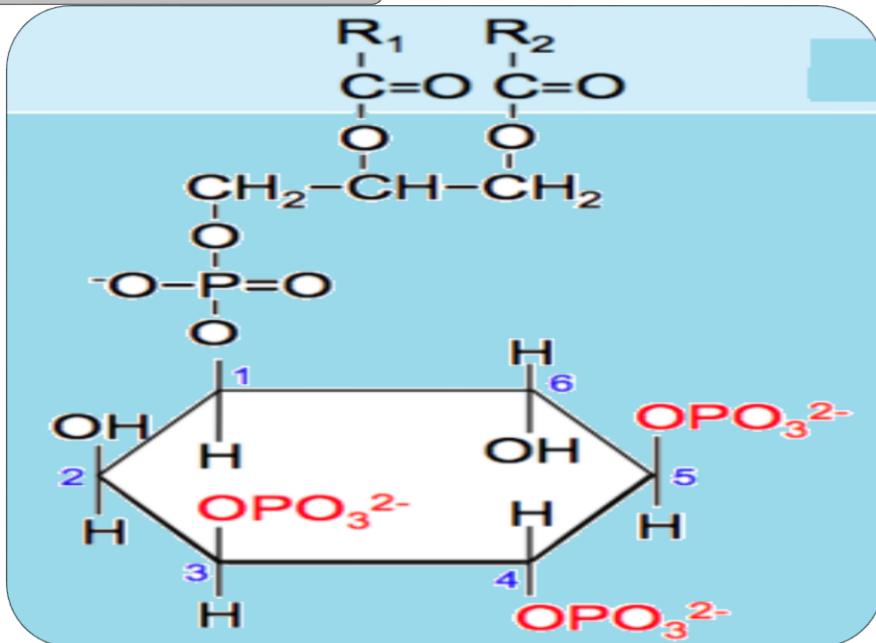
Phospholipids

Glycolipids

Phosphoglycerides

Phosphoinositides

Phosphosphingosides



# Compound lipids

Phospholipids

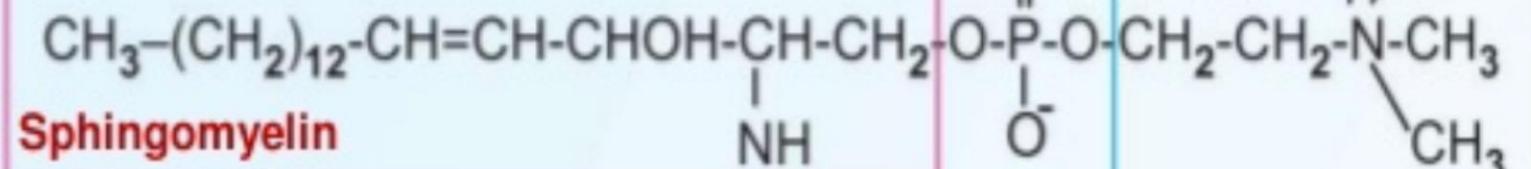
Glycolipids

Phosphoglycerides

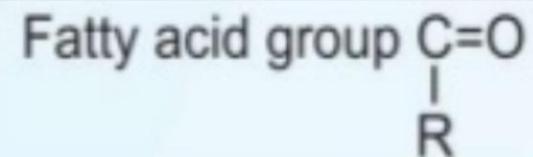
Phosphoinositides

Phosphosphingosides

Sphingosine group

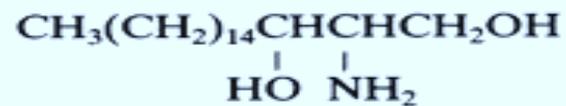


**Sphingomyelin**

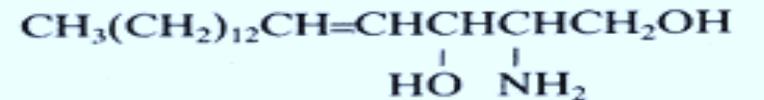


Choline group

*dihydrosphingosine*



*sphingosine*



# Compound lipids

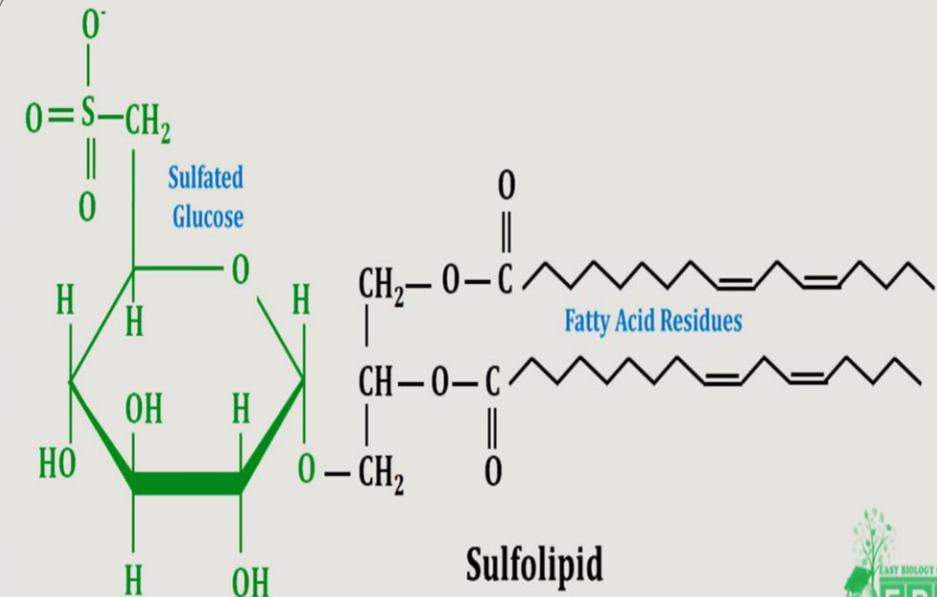
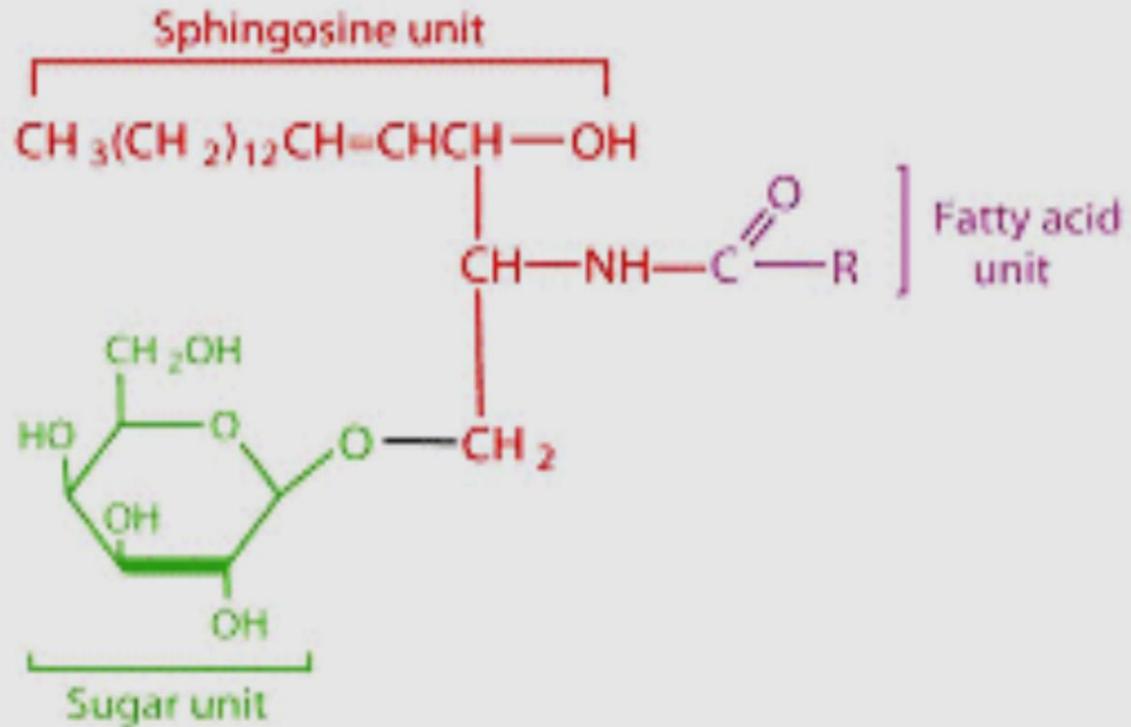
## Phospholipids

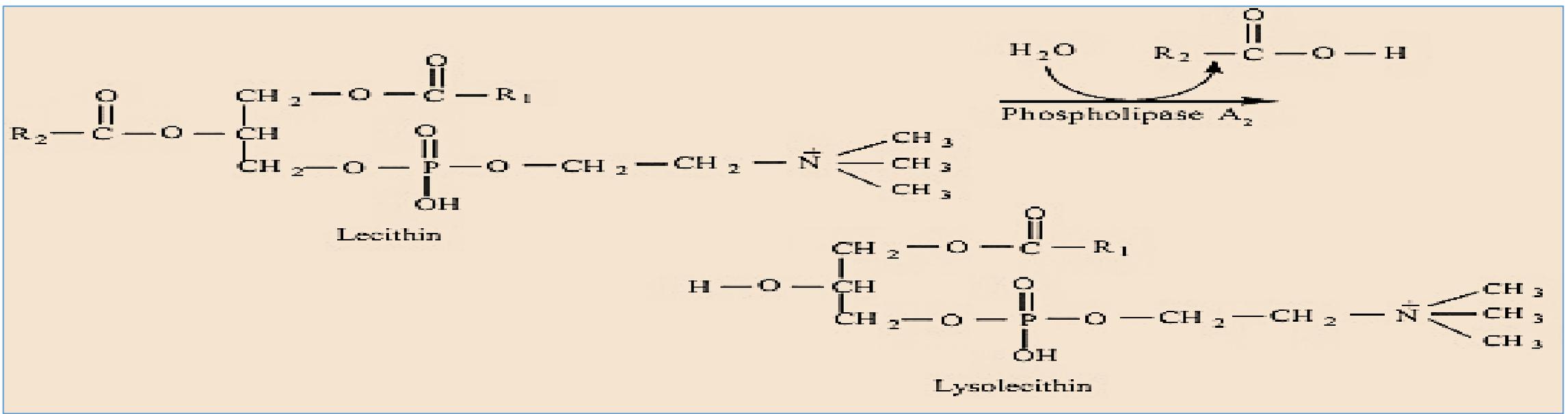
Phosphoglycerides

Phosphoinositides

Phosphosphingosides

## Glycolipids





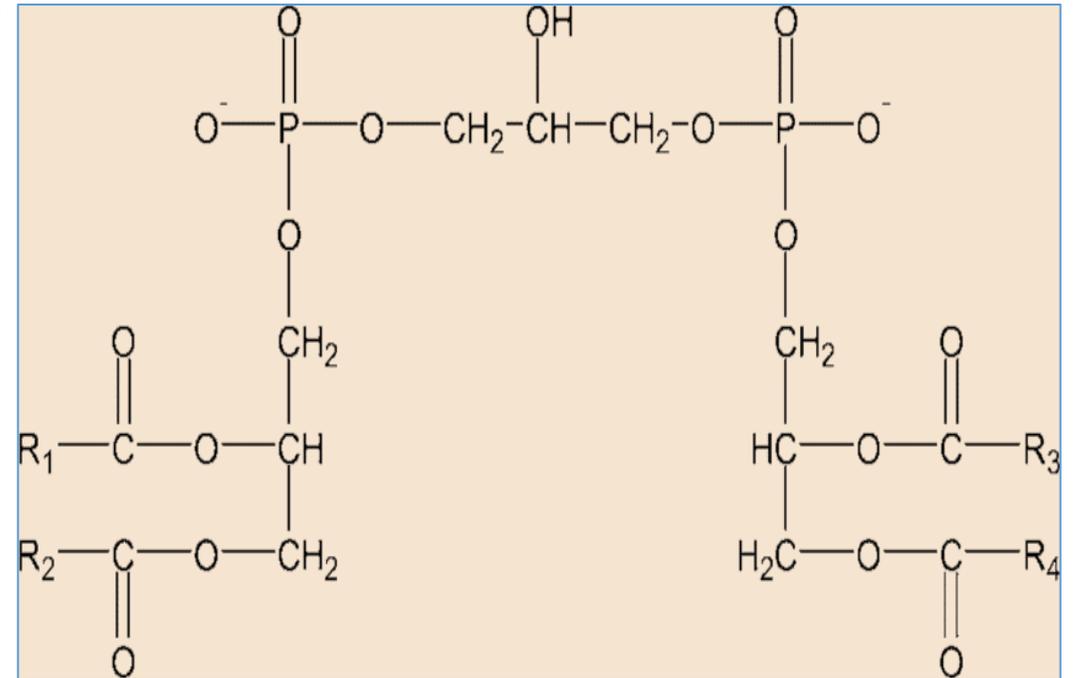
### (Cardiolipin)

Two molecules of phosphatidic acid esterified through phosphate to an additional molecule of glycerol are called cardiolipin.

This is the only human glycerophospholipid that is antigenic.

cardiolipin is recognized by antibodies raised against *Treponema* the bacterium that causes syphilis

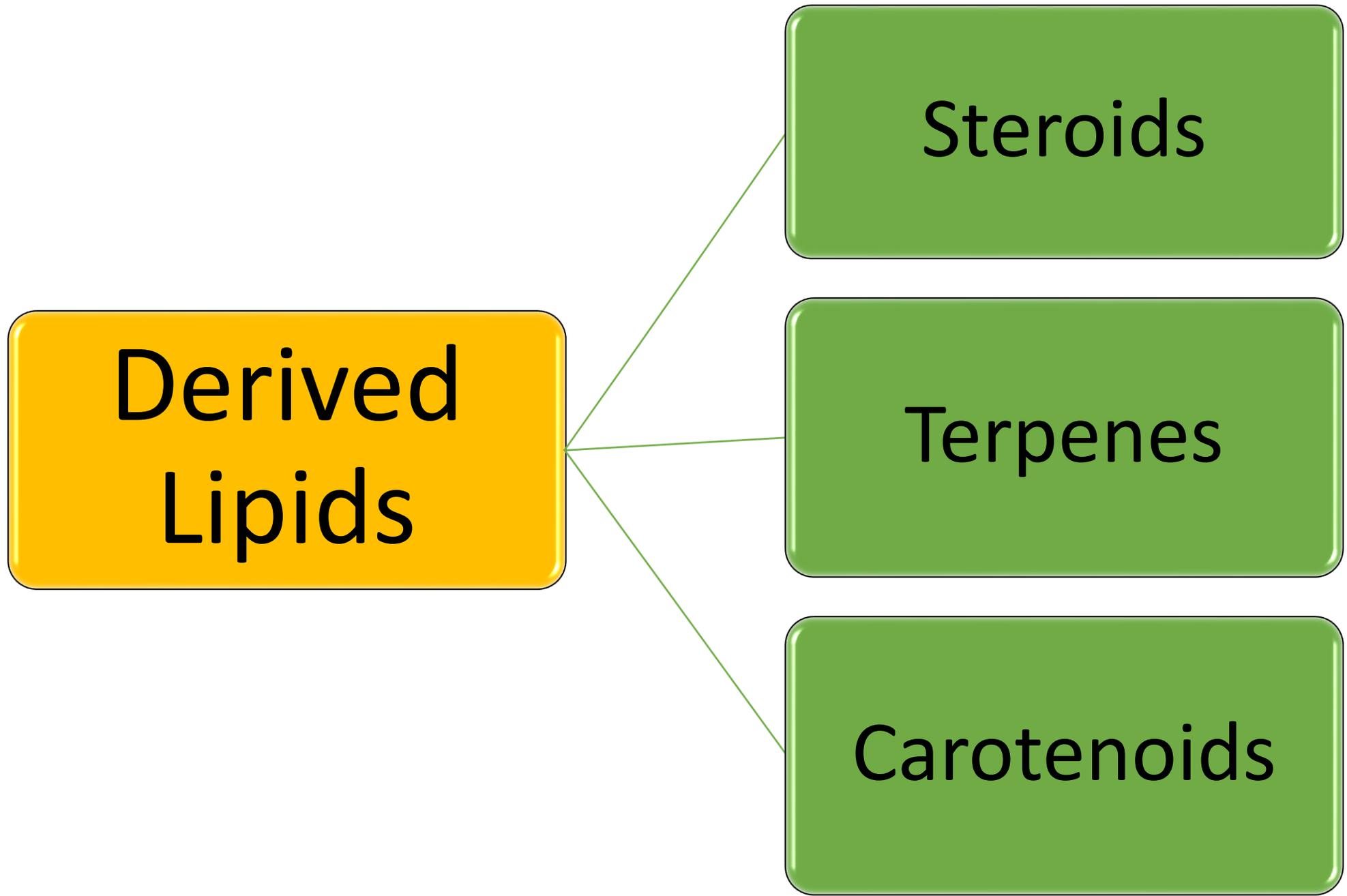
[Cardiolipin is an important component of the inner mitochondrial membrane and bacterial membranes.]



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Derived  
Lipids

Steroids

Terpenes

Carotenoids

# Steroids

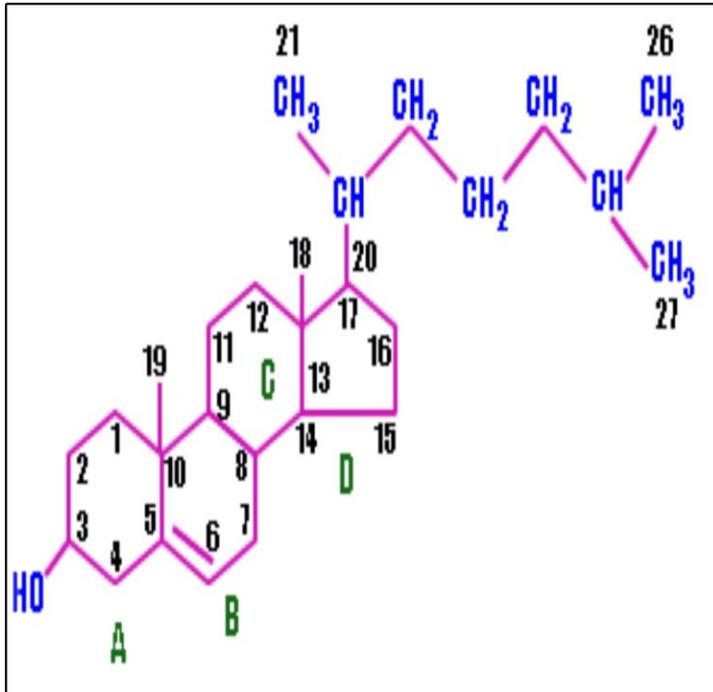
- \* Containing Cyclo-pentane-perhydro-phenanthrene (CPPP)
- \* -OH attachment ---sterols
- \* It classifies depending on side chain length into:

29C, 28C & 27C

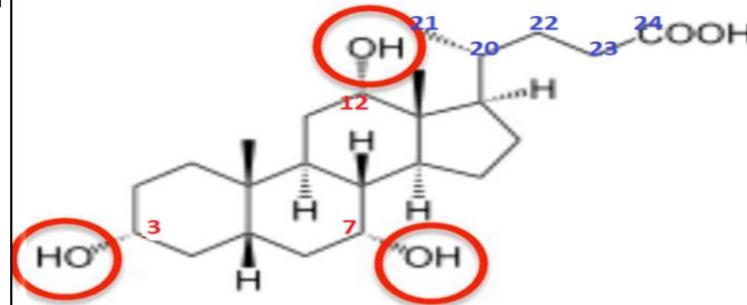
- \* Coprosterol in feces
- \* Ergosterol in ergot, yeast & Neurospora mould
- \* Lanosterol in wool fat

24C

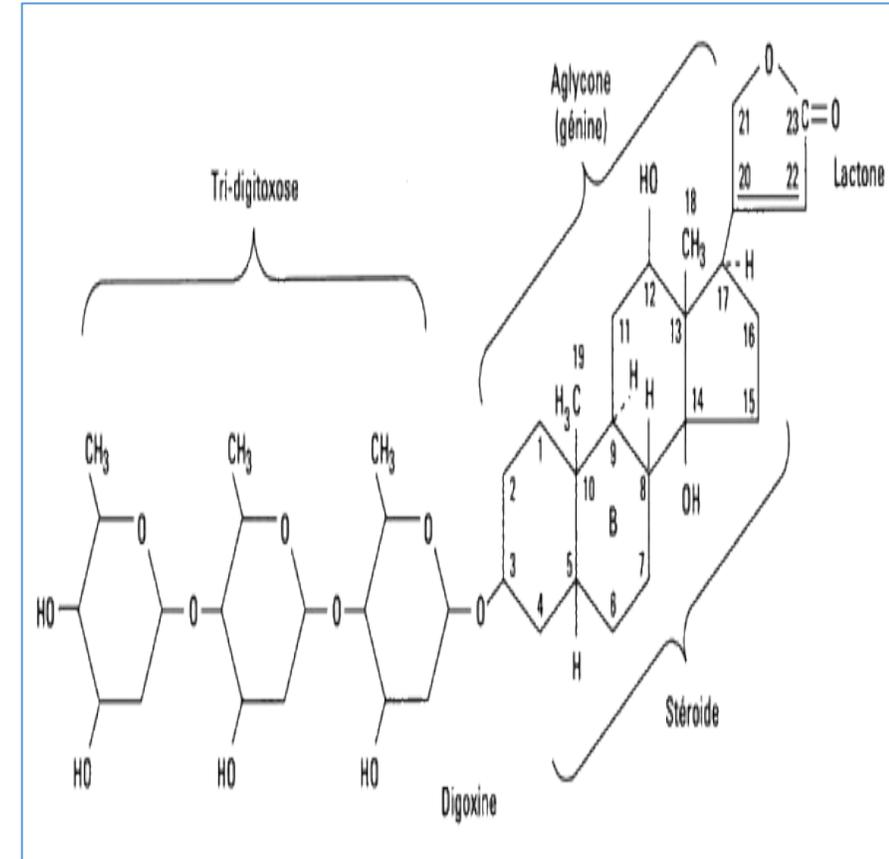
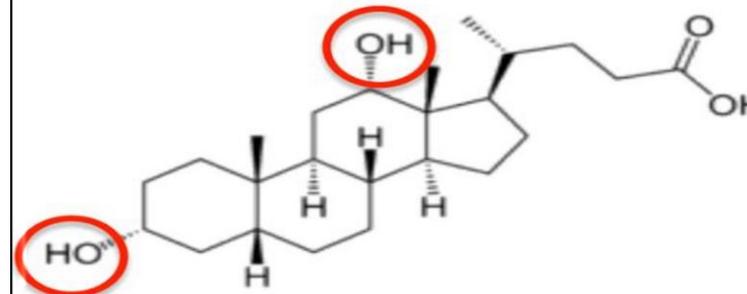
17C, 19C & 18



cholic acid

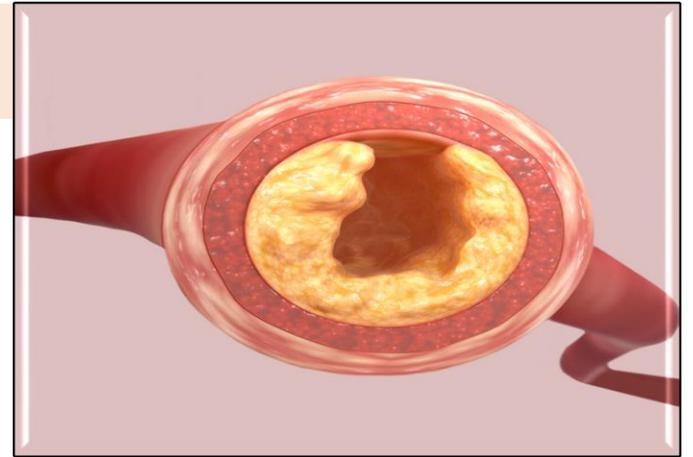


deoxycholic acid



# Dietary Fat and Cholesterol

1. What are essential fatty acids?
2. What are Omega-3 & Omega-6 Fatty Acids
3. What are brown & white fats?
4. How is blood cholesterol transported by the body?



## Characteristics of HDL and LDL blood cholesterol carriers.

	LDL	HDL
<b>Full Name:</b>	Low Density Lipoprotein.	High Density Lipoprotein.
<b>What it does:</b>	Takes cholesterol from the liver to the rest of the body.	Primarily takes cholesterol from body tissue back to liver.
<b>Effect on the risk for heart disease:</b>	High amounts increase risk.	High amounts reduce risk.
<b>Nickname:</b>	“Bad” cholesterol.	“Good” cholesterol.

## Nutrition Facts

Serving Size 5 Crackers (16g)  
 Servings Per Container About 14

### Amount Per Serving

**Calories** 80    Calories from Fat 35

**% Daily Value\***

**Total Fat** 4g    **6%**

Saturated Fat 0.5g    **3%**

Trans Fat 0g

Polyunsaturated Fat 2g

Monounsaturated Fat 1g

**Cholesterol** 0mg    **0%**

**Sodium** 150mg    **6%**

**Total Carbohydrate** 10g    **3%**

# Terpenes

## Mono-terpens & Sesqui-terpenes

- \* Fragrances found in plants
- \* Myrcene ---- oil of bay
- \* Geraniol--- rose oil
- \* Limonene --- lemone oil
- \* Menthol ---peppermint oil

## Di-terpenes

- \* Found in resins & balsams
- \* From Pine wood
- \* Vitamin A
- \* Abietic acid
- \* Sapietic acid

## Tri-terpenes

- \*(Squalene) the main constituent of shark liver oil
- \* Saponin

## Poly-terpenes

- \*Found in latex of many tropical plants
- \* Rubber made of 500-5000 isoprene units

• Terpenes are derived from the union of **five carbon (C<sub>5</sub>) isoprene** units (it can decompose at high temperature to give isoprene)



• Terpenes are **classified** by the **number of C<sub>5</sub> units**  
 Monoterpenes (two C<sub>5</sub> units) , Sequiterpenes (three C<sub>5</sub> units), and Diterpenes ( four C<sub>5</sub> units).

**Larger terpenes** include triterpenes (30 carbons), tetraterpenes (40 carbons), and Polyterpenes ([C<sub>5</sub>]<sub>n</sub> carbons, where n>8)

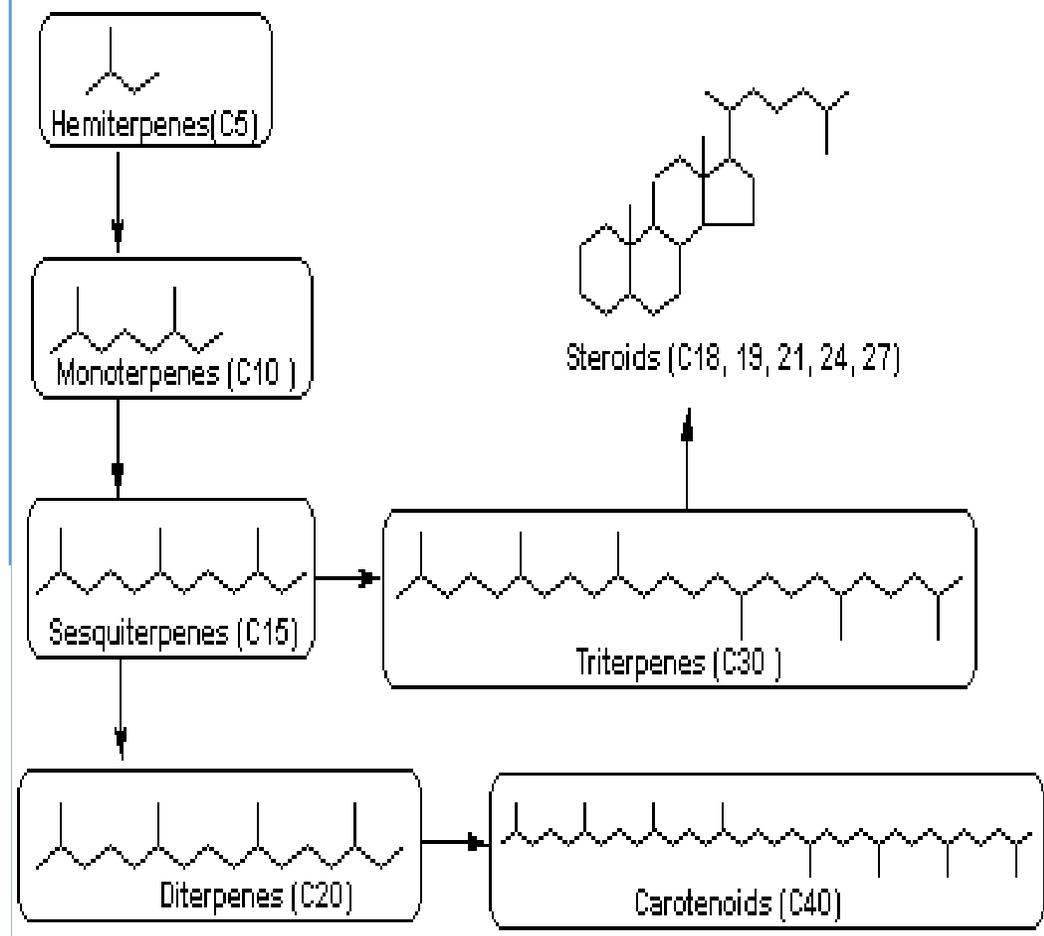
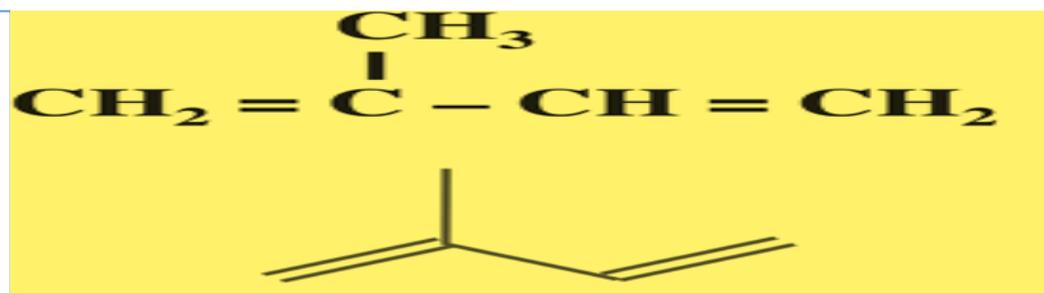
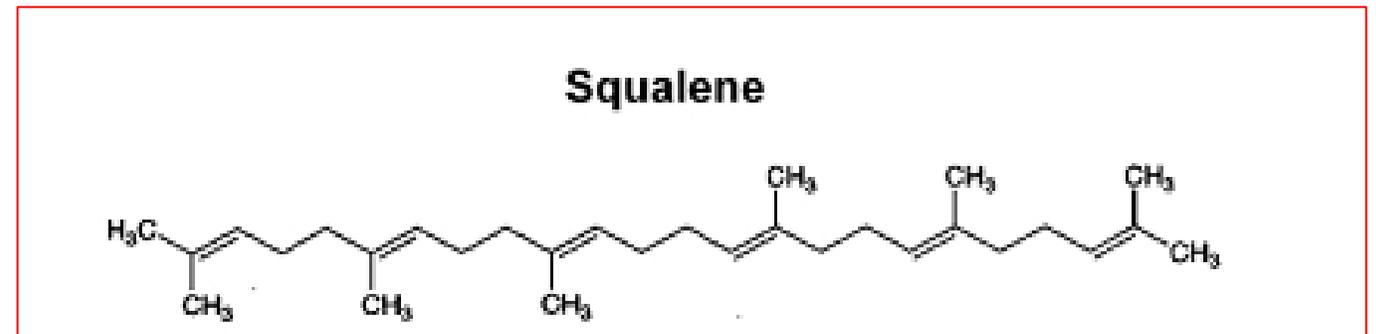
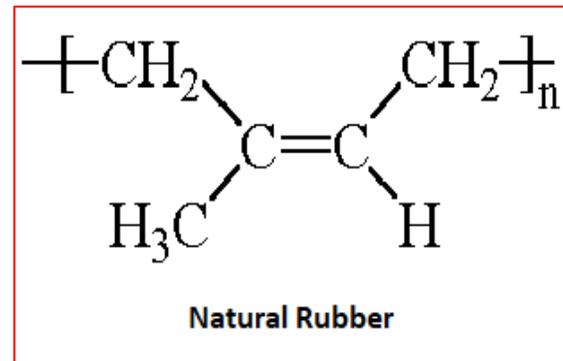
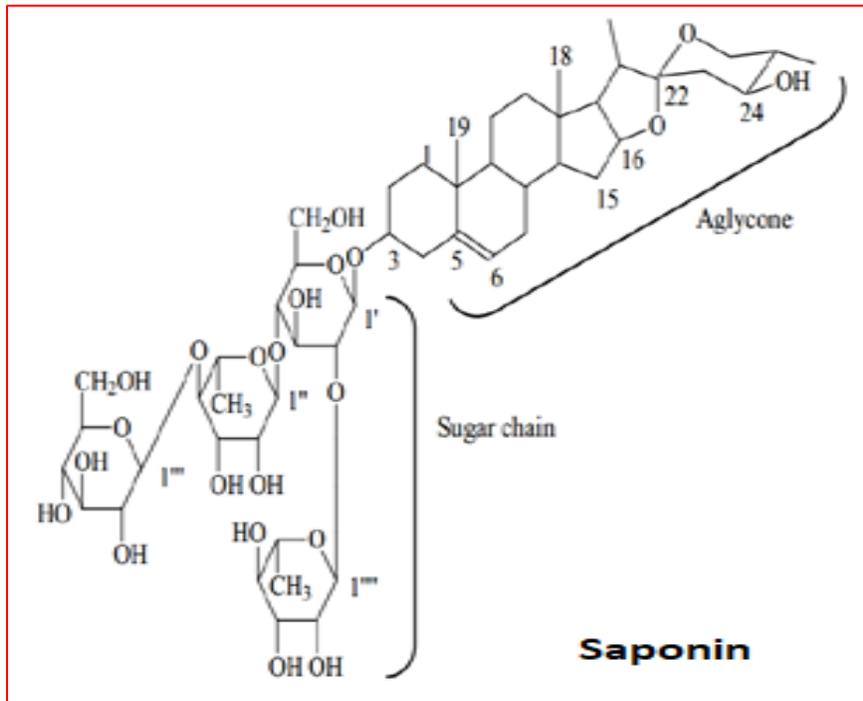
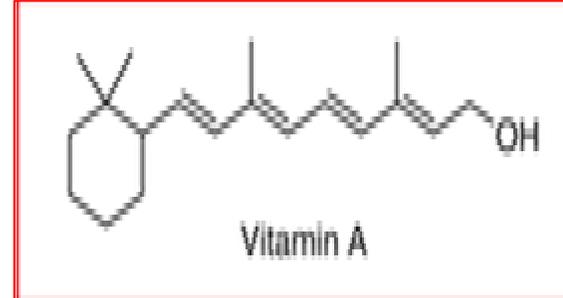
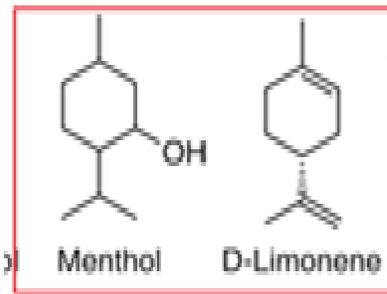
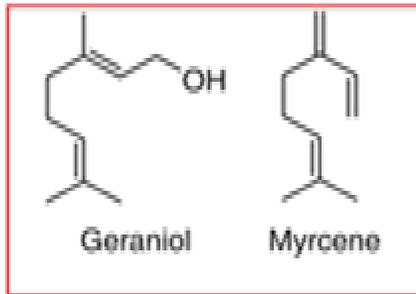
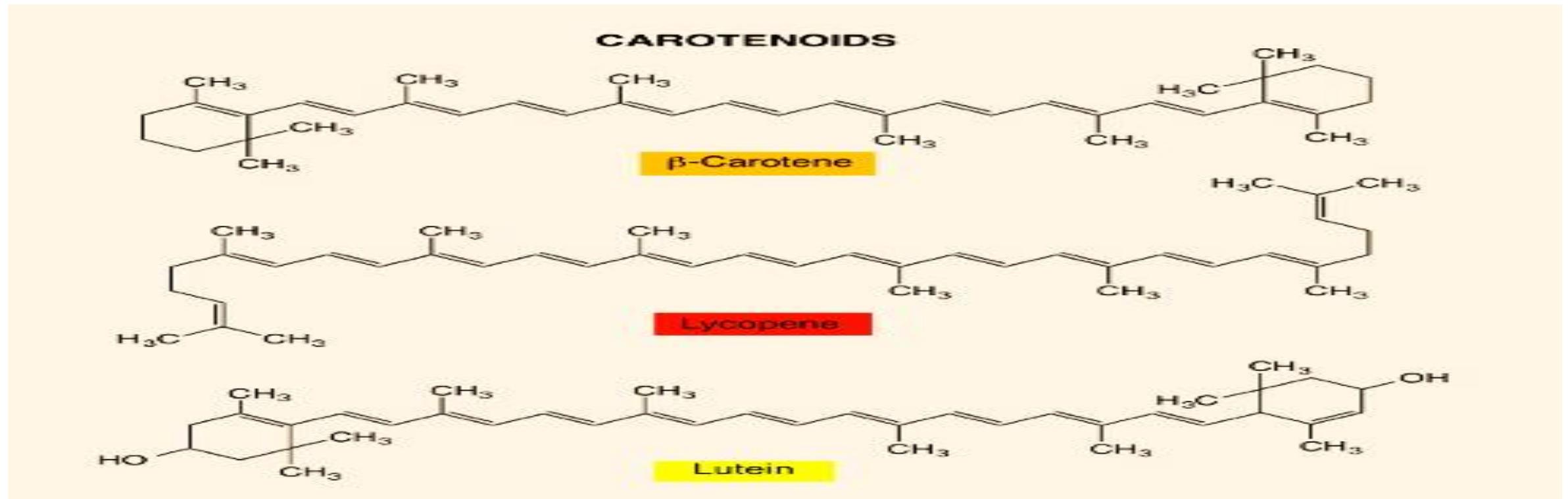
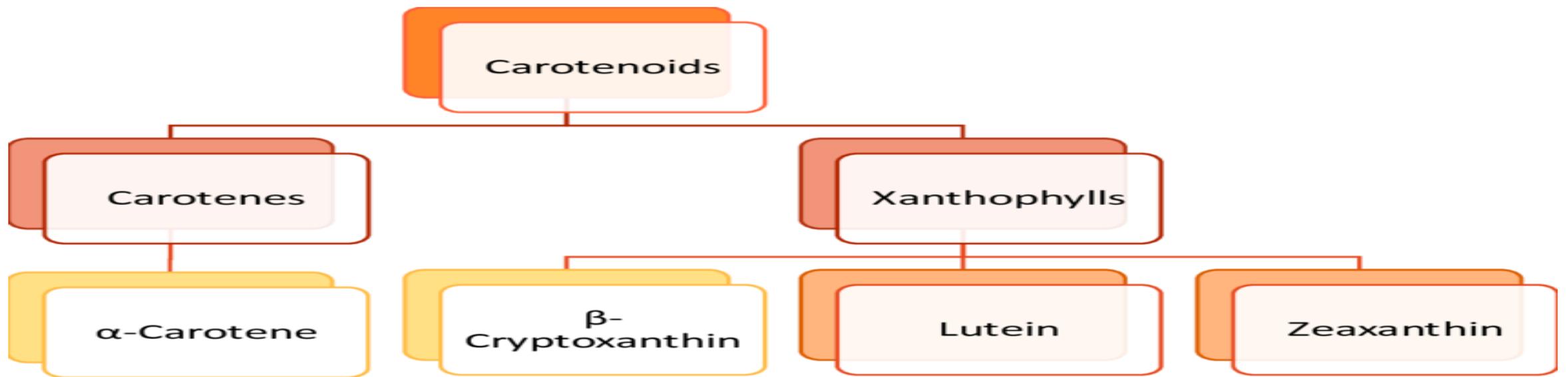


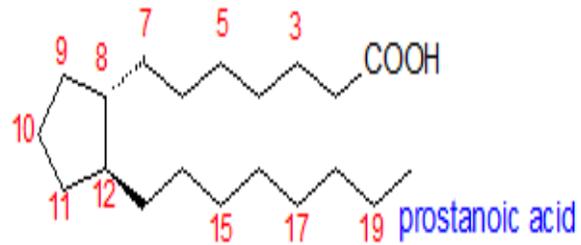
Fig.1 Biosynthetic Pathway of Terpene Skeletons

# Chemical structure of some terpenes

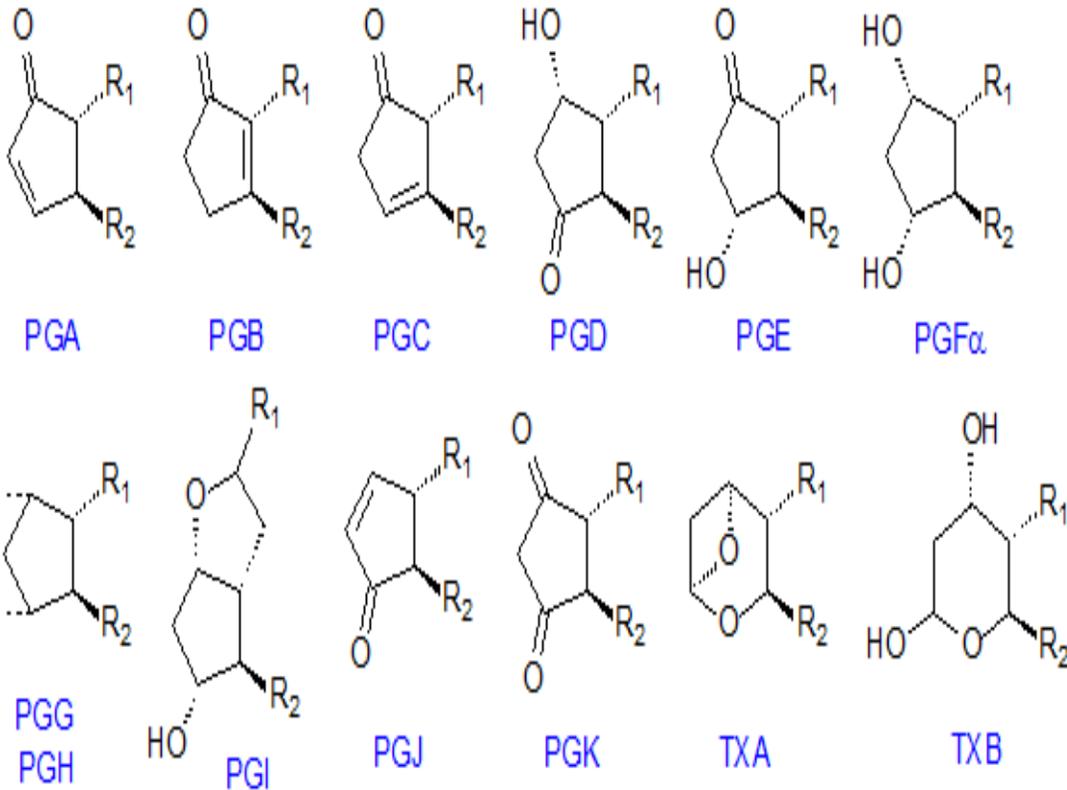




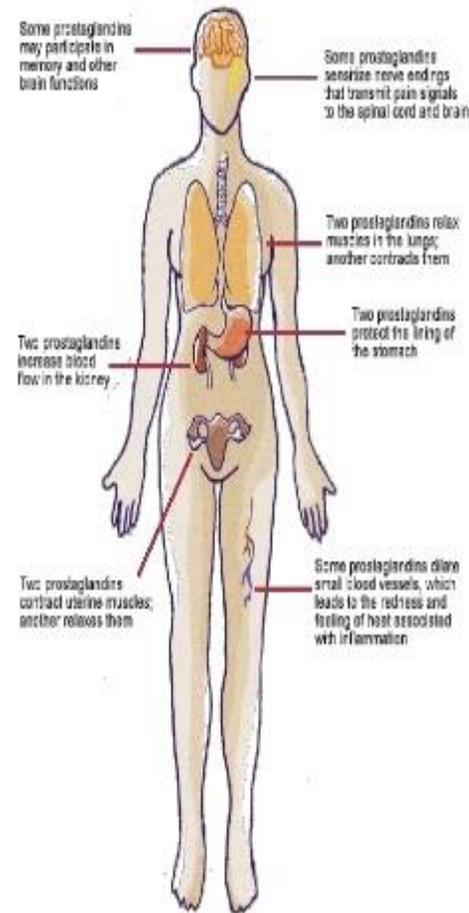
# Prostaglandins:



The prostaglandins



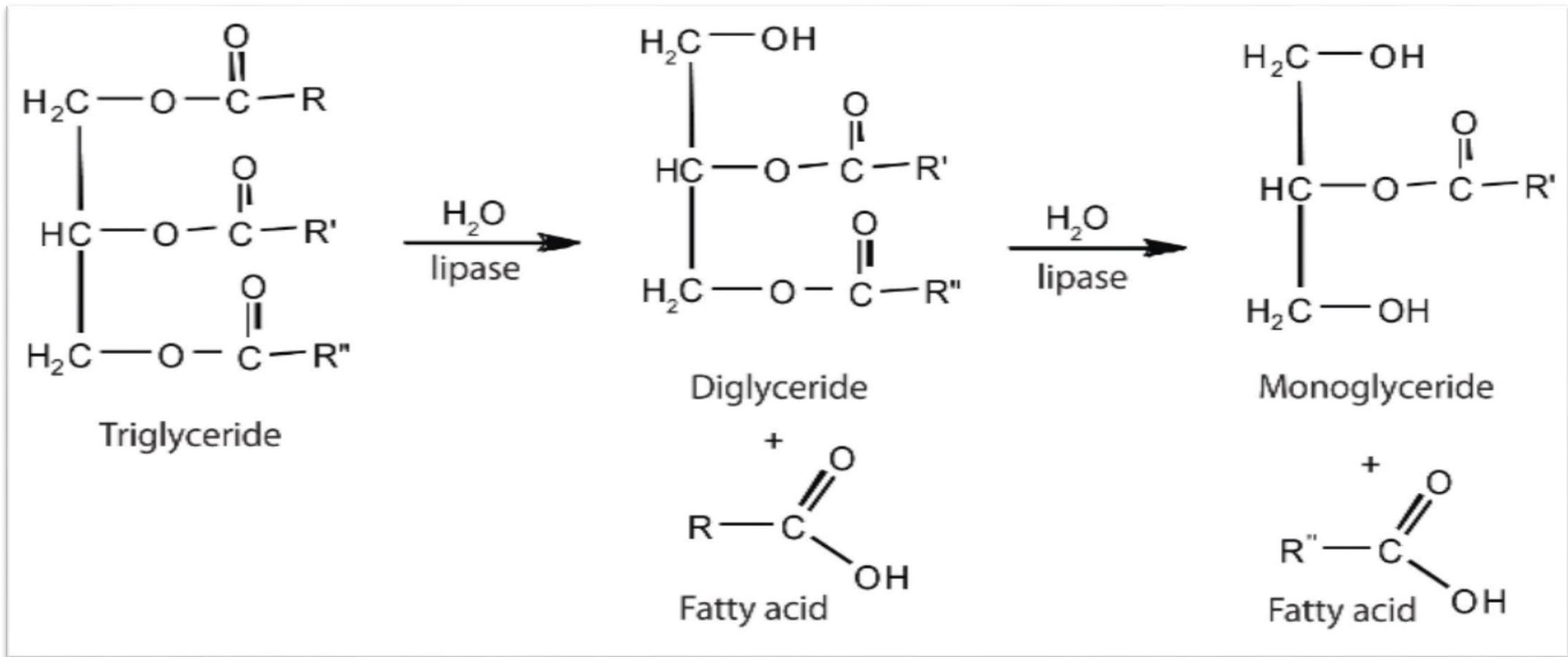
## Prostaglandins (PGs)



- PGs can have influences on many body functions such as:
  - Respiration
  - Blood pressure
  - GI secretions
  - Inflammation
  - Reproductive Systems
- Most PGs regulate cells by the production of cAMP.
- Play roles in the treatment of various conditions including high blood pressure, ulcers, and asthma.
- Aspirin cause their effects by altering the functions of PGs in the body.

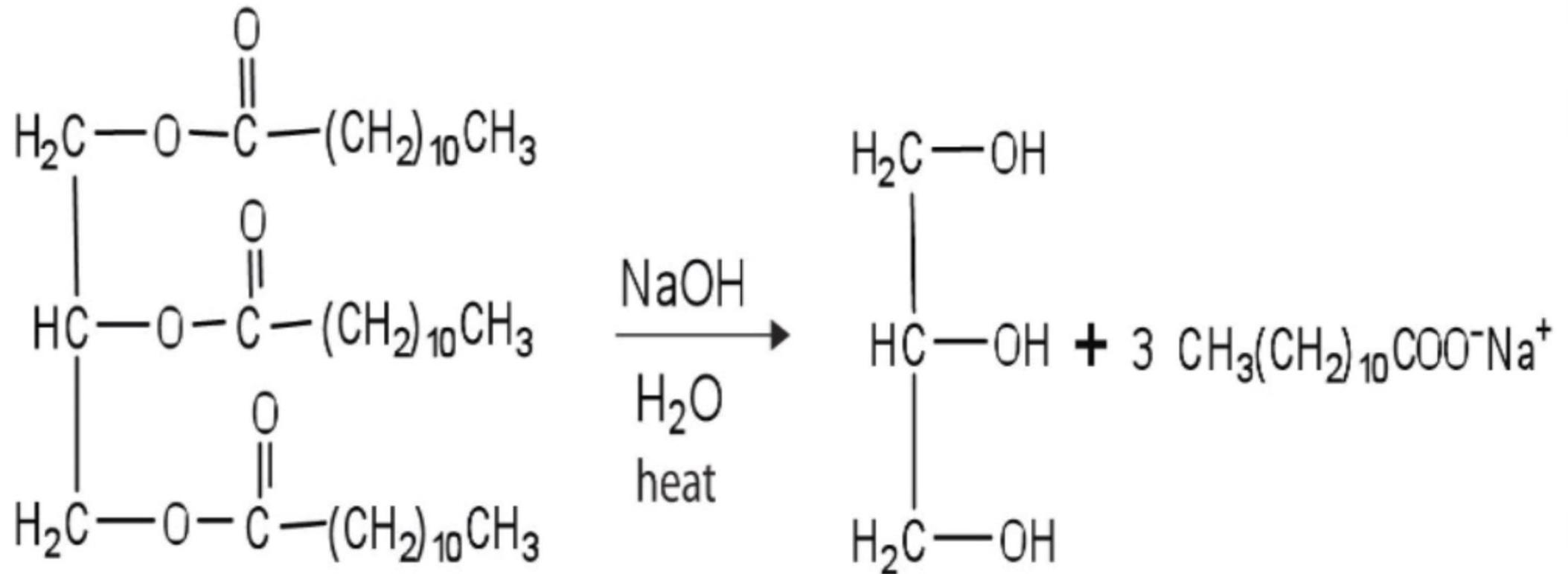
# The main chemical reactions of Lipids

## 1- Hydrolysis (chemically and enzymatically)



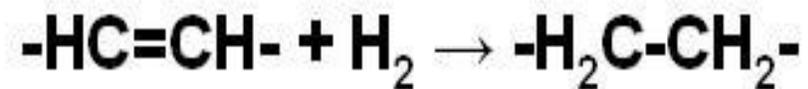
# The main chemical reactions of Lipids

## 2-Saponification: the preparation of soaps

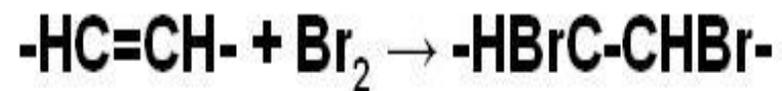


# The main chemical reactions of Lipids

## 3- Hydrogenation of oils



## 4- Halogenation



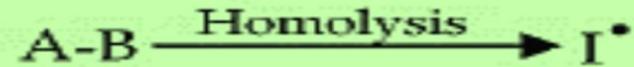
# The main chemical reactions of Lipids

## 5- Oxidation of fats and oils

### Factors Affecting Autoxidation

1. Energy in the form of heat and light
2. Catalysts (Metal)
3. Double bonds
4. Enzymes
5. Chemical oxidants
6. Oxygen content and types of oxygen
7. Natural antioxidants

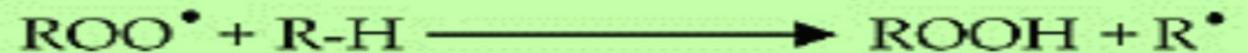
### Radical formation



### Initiation



### Propagation



### Termination



# The main chemical reactions of Lipids

## **Rancidity**

**1- Hydrolytic rancidity**

**2- Oxidative rancidity**

## **Prevention of rancidity**

1- Addition of antioxidants to fats and oils specialty the natural antioxidant tochopherol (vitamin E).

2- Also, avoid exposure of fats to light, moisture and high temperature.

University of Baghdad  
College of Science  
Department of Chemistry  
General Biochemistry (1)  
3<sup>rd</sup> class

By

**Assist. Professor Dr. Thikra Hasan Mathkor**

# Nucleosides And Nucleotides

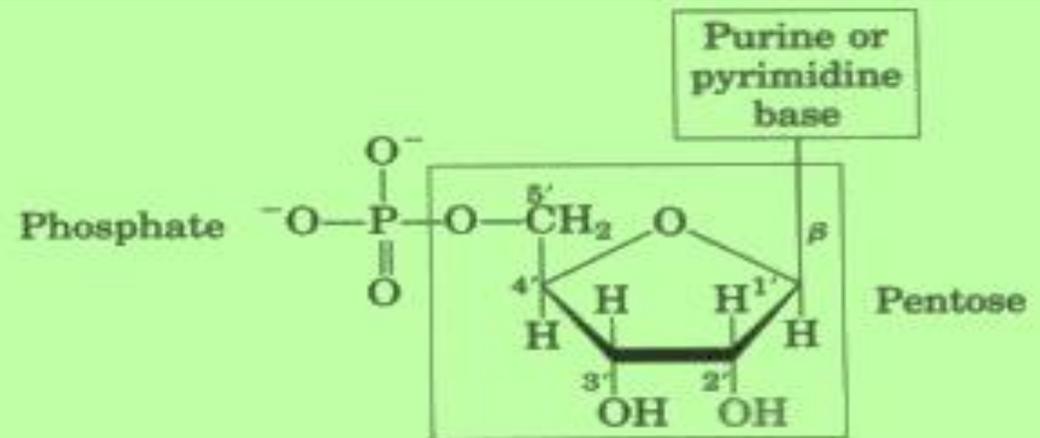
- **The importance of nucleoside & nucleotide**
- **Purine & Pyrimidine Bases**
  - \* Physicochemical properties of purine and pyrimidine bases
  - \* Unusual or minor purine and pyrimidine bases
- **Nucleosides**
  - \* Nomenclature Of Nucleosides
- **Nucleotides**
  - \* Nomenclature Of Nucleotides
- **Nucleoside di and triphosphates**
- **Dinucleotides**
- **Synthetic Purine and pyrimidine analogs**

# The importance of nucleoside & nucleotide

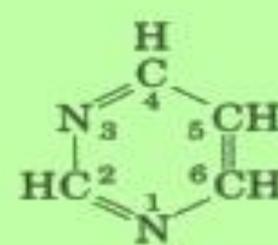
1. The best role of purine and pyrimidine nucleotides is to serve as the monomeric precursors of RNA and DNA.
2. They play an important role in carbohydrate, fat and protein metabolism.
3. The purine nucleotides also act as the high energy source
  - ATP (ATP is energy currency of cell)
  - UDP- glucose and UDP-galactose in carbohydrate metabolism
  - CDP-acylglycerol in lipid synthesis
4. Several hormones exert their action through cyclic AMP or cAMP
5. Diadenosine triphosphate and diadenosine poly phosphate are neurotransmitters
5. Are components of coenzymes FAD, NAD, NADP in oxidative phosphorylation of respiratory chain.

# Nucleosides & Nucleotides

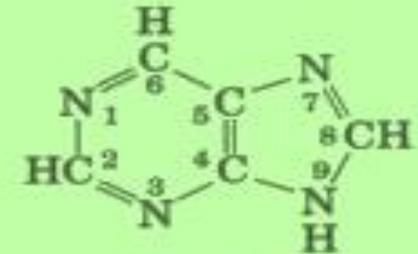
- **NUCLEOTIDES**
- **Chemical nature of nucleotides**
- Hydrolysis of nucleotides produce nitrogen bases, sugars and phosphate.
- *Nitrogenous bases.*  
Nucleotides contain two types of nitrogenous bases. They are purine bases and pyrimidine bases.



(a)



Pyrimidine



Purine

(b)

# Nucleic Acids

(DNA & RNA)

## Nucleotides

(Nitrogen Bases + Sugar + Phosphate)

## Nucleosides

(Nitrogen Bases + Sugar )

## Nitrogen Bases

### Purines

Adenine

Guanine

### Pyrimidine

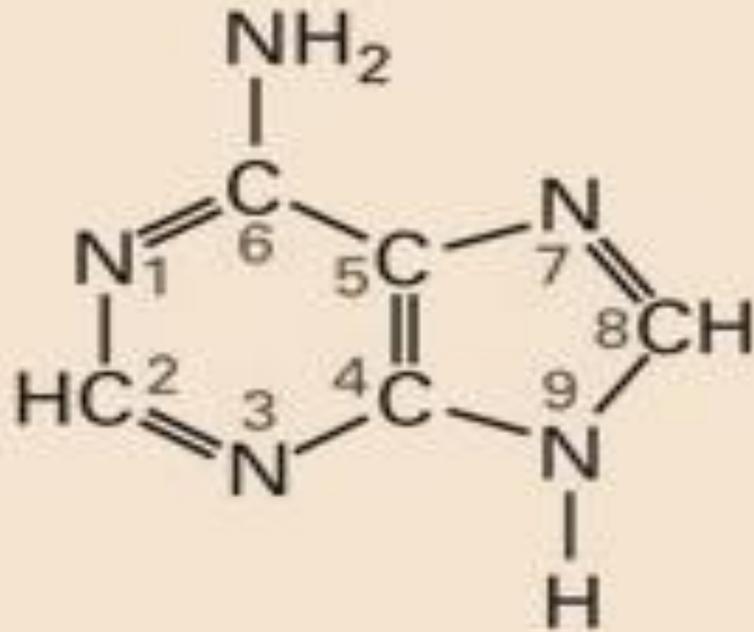
Uracil

Thymine

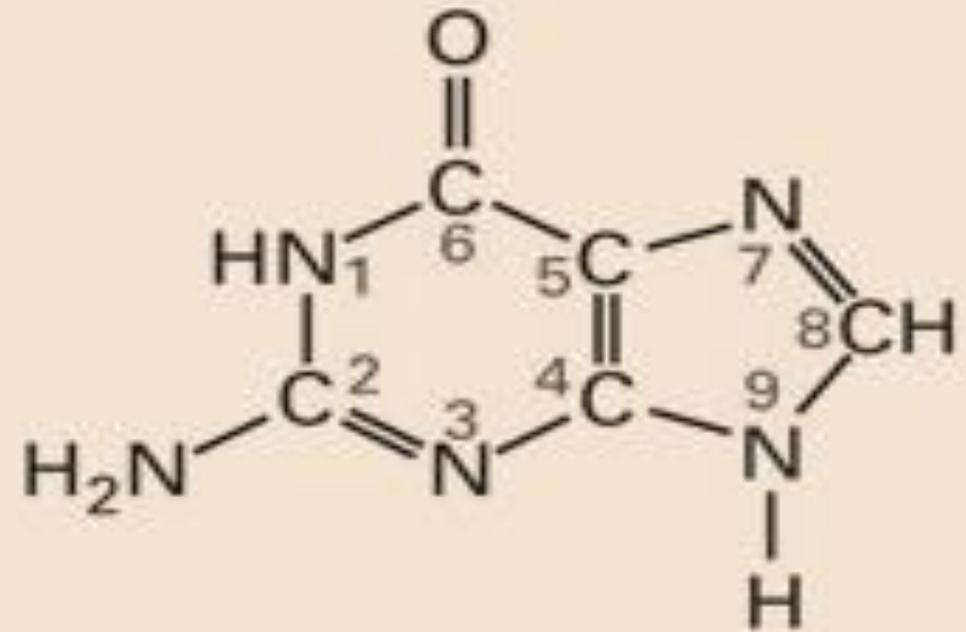
Cytosine

# Purine bases

## PURINES



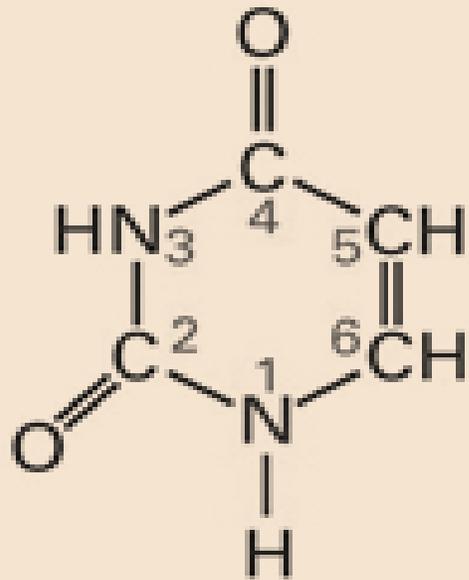
**Adenine (A)**



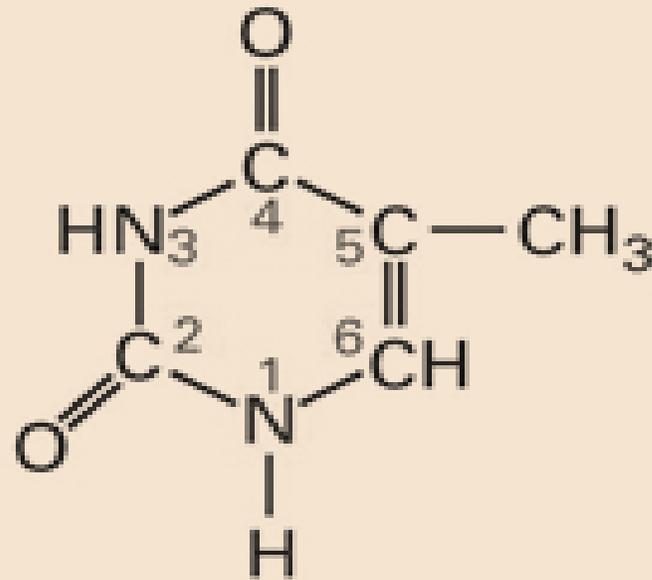
**Guanine (G)**

# Pyrimidine bases

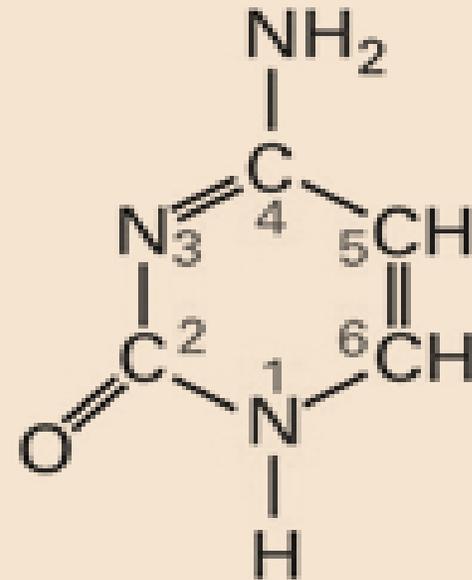
## PYRIMIDINES



**Uracil (U)**



**Thymine (T)**

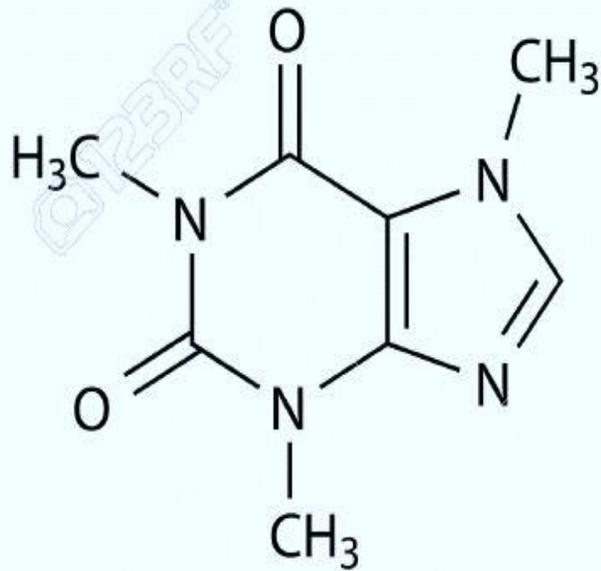


**Cytosine (C)**

# Physicochemical properties of purine and pyrimidine bases

- They are soluble in water. Uric acid and xanthine tend to crystallize at physiological pH at high concentration.
- They absorb light in UV region at 260 nm. This property is used for detection and quantitation of nucleotides.
- They are capable of forming hydrogen bonds.

# Unusual or minor purine and pyrimidine bases



Caffeine



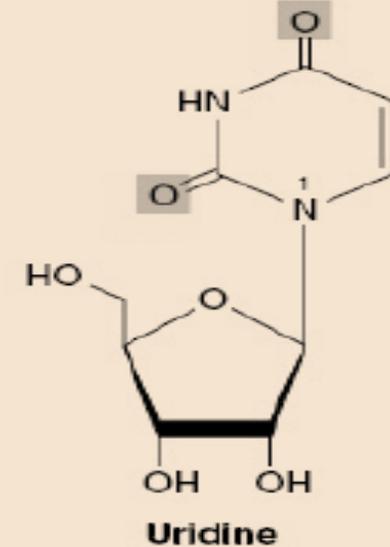
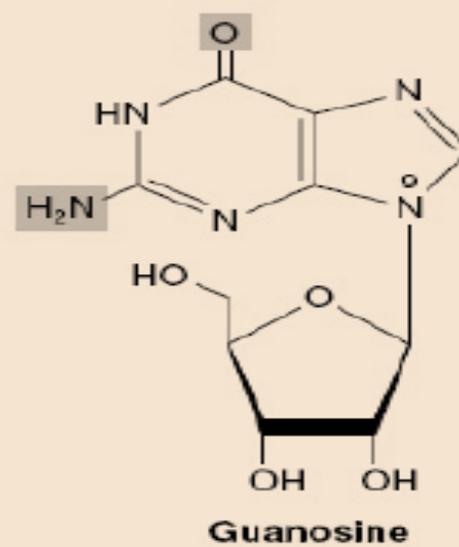
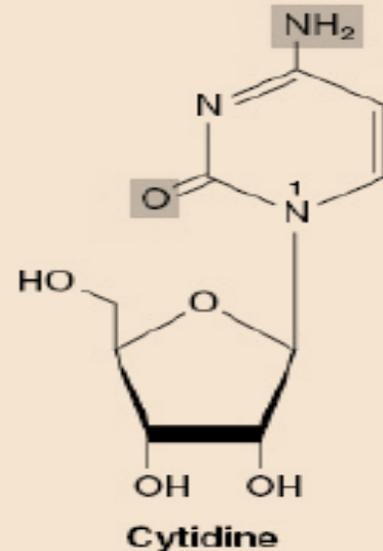
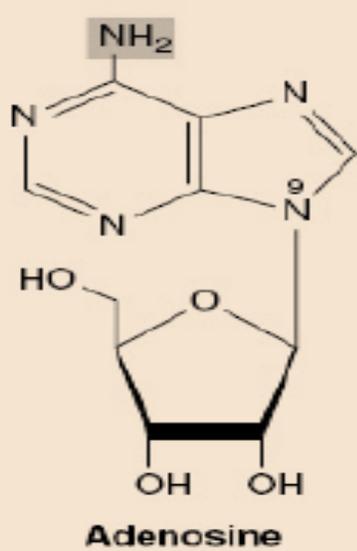
Theophylline



Theobromine

# Nucleosides

**Nucleosides are derivatives of purines and pyrimidines that have a sugar linked to a ring nitrogen.**

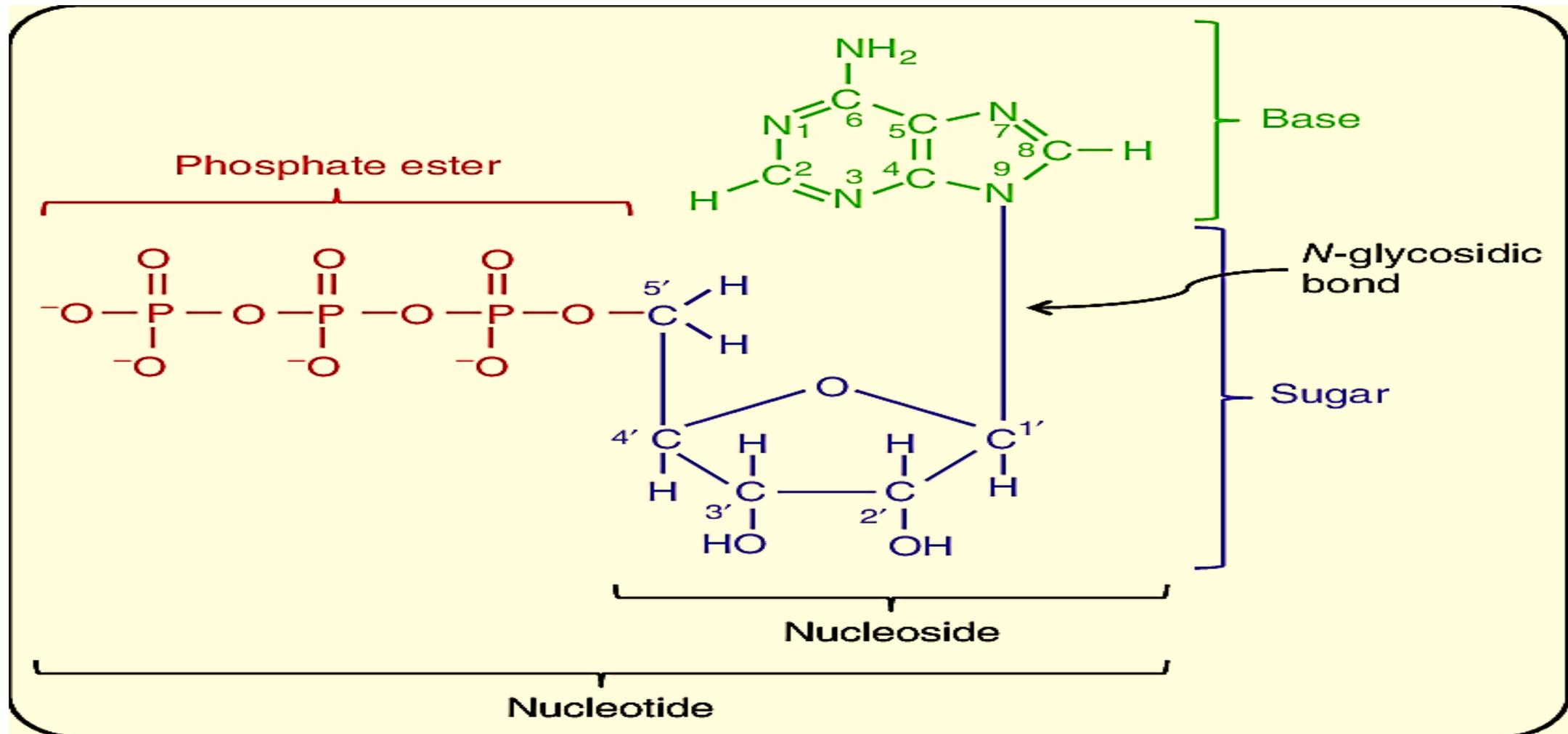


**The sugar is linked to the heterocyclic base via a  $\beta$ -N-glycosidic bond, almost always to N-1 of a pyrimidine or to N-9 of a purine.**

# Nomenclature Of Nucleosides

Adenine	Adenosine	A
	Deoxyadenosine	dA
Guanine	Guanosine	G
	Deoxyguanosine	dG
Cytosine	Cytidine	C
	Deoxycytidine	dC
Thymine	Thymidine	T
	Deoxythymidine	dT
Uracil	Uridine	U
Cytosine	Cytidine	C
	Deoxycytidine	dC

# Nucleotides



- Nucleotides are the nucleosides phosphorylated on one or more of the hydroxyl groups of the sugar. Thus,
- **Adenosine monophosphate (AMP or Adenylate)**
  - = Adenine + ribose + phosphate
- **2-deoxyadenosine monophosphate (dAMP or deoxyadenylate)**
  - = Adenine + 2-deoxyribose + phosphate.
- **Thymidylic acid (TMP)**
  - = Thymine + 2-deoxyribose + phosphate.
- **Uridylic acid (UMP)**
  - = Uracil + ribose + phosphate.

# Nomenclature Of Nucleotides

**Table 14.2 Nomenclature of nucleotides**

<b>Name</b>	<b>Alternate name</b>	<b>Abbreviation</b>
Adenosine monophosphate	Adenylic acid	AMP
Deoxy adenosine monophosphate	Deoxyadenylic acid	dAMP
Guanosine monophosphate	Guanylic acid	GMP
Deoxy guanosine monophosphate	Deoxy guanylic acid	dGMP
Cytidine monophosphate	Cytidylic acid	CMP
Deoxy cytidine monophosphate	Deoxy cytidylic acid	dCMP
Deoxy thymidine monophosphate	Deoxy thymidylic acid	dTMP
Uridine monophosphate	Uridylic acid	UMP
Inosine monophosphate	Inosinic acid	IMP
Orotidine monophosphate	Orotidylic acid	OMP

# Nucleoside di and triphosphates

**Table 14.3 Some nucleoside di and triphosphates**

<b>Name of diphosphate</b>	<b>Abbreviation</b>	<b>Name of triphosphate</b>	<b>Abbreviation</b>
Adenosine diphosphate	ADP	Adenosine triphosphate	ATP
Deoxy Adenosine diphosphate	dADP	Deoxy Adenosine triphosphate	dATP
Guanosine diphosphate	GDP	Guanosine triphosphate	GTP
Deoxy Guanosine diphosphate	dGDP	Deoxy Guanosine triphosphate	dGTP
Cytidine diphosphate	CDP	Cytidine triphosphate	CTP
Deoxy Cytidine diphosphate	dCDP	Deoxy Cytidine triphosphate	dCTP
Thymidine diphosphate	TDP	Thymidine triphosphate	TTP
Deoxy Thymidine diphosphate	dTDP	Deoxy Thymidine triphosphate	dTTP
Uridine diphosphate	UDP	Uridine triphosphate	UTP