D-Ribose

D-arabinose

D-xyllose

Glucose, grape sugar, diabetic sugar
2. Lactose

\[
\begin{align*}
&\text{D-Galactose} \\
&\text{D-Fructose}
\end{align*}
\]

Lactose

Lactic acid

Skeletal formula

\[\text{Lactose (ammonium salt)}\]

\[\text{ATP} + \text{Galactose} \rightarrow \text{Fructose-6-phosphate}\]

\[\text{Galactose} \rightarrow \text{Fructose-6-phosphate}\]

D-Fructose, fruit sugar, Levulose

\[\text{D-Fructose} \rightarrow \text{D-Fructofuranose} \rightarrow \text{D-Fructopyranose}\]
Glycosides (Alkyl ether)

Vanillin: D glucosyl ether

Metabolites of sugar metabolism.

1. Anomeric carbon atoms

2. Aldoses and ketoses
4D-Glucosyl-1α-D-Glucoside (β-Maltose)

6D-Glucosyl-1α-D-Glucoside (α-Isomaltose)
Tri saccharides

I. Reducing sugar

Maltotriose
Rhamnose

Raffinose

II. Non-reducing sugar

Raffinose
Fructose, β-D-α-L-glucose
6-D-α-L-galactose

Sucrose

Raffinose
الخطوة 1: يبدأ النبات عن طريق إضافة مكونات حمضية ثم تكوين مركبات كيميائية رائعة ثم تكوين مركبات ورم ايكات تكوين

\[ \text{Amylose} \]

\[ \text{Amylopectin} \]
الدكسيرين

يكون من ألياف، وتستخدم في الأنظمة الدموية وأدوات التعبير. يحتوي الدكسيرين على العديد من الألياف السهلة التكون واختراقها مادة عضوية.

الدكسيرين هو معروف بأنه يمكن تضمينه في الخلايا الحيوانية.

الغلوسطين

وهو نوع من الدكسيرين الذي يحتوي على مضادات أكسدة كثيرة وETF في الخلايا الحيوانية.

الذكور:

الذكور: كلما زادت الخلايا العضوية، كلما زادت كمية الذكور في الخلايا الحيوانية.

الكلورور

الكلورور هو نوع من مادة عضوية مجهولة الشكل، معروفة بـ1330.1238.

الكلورور

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Carbohydrates of physiologic significance:

Carbohydrates are widely distributed in plants and animals, they have important structural and metabolic roles.

For example, carbohydrates are structural components of all living organisms. They are also important energy sources, providing about 40% of the caloric intake of the average American diet. Carbohydrates are classified into two main categories: simple carbohydrates (monosaccharides) and complex carbohydrates (polysaccharides).

Simple carbohydrates are monosaccharides, which are the basic units of carbohydrates. Examples include glucose, fructose, and galactose. These sugars are found in fruits, vegetables, and milk.

Complex carbohydrates are polysaccharides, which are large molecules formed by the combination of many monosaccharide units. Examples include starch, cellulose, and glycogen. These carbohydrates are found in plants and some animals.

Carbohydrates play a crucial role in human health, providing energy, supporting growth, and maintaining normal function of many bodily processes. They are essential for cell structure, energy production, and the synthesis of hormones and neurotransmitters.

In addition, carbohydrates are involved in the regulation of blood sugar levels, which is crucial for the prevention and management of diseases such as diabetes mellitus. Carbohydrates are also important in the prevention of obesity and the maintenance of a healthy weight.
Aldehydeose α 1,4-linked to a C3 sugar.

\[
\text{CH}_3\text{OH} \\
\text{H} - \text{O} - \text{H} \\
\text{H} - \text{O} = \frac{1}{2} \text{H} \text{O} \\
\text{H} - \text{O} - \text{H} \\
\text{H} = 0
\]

 Aldopentose 1,4-linked to a C3 sugar.

\[
\text{O} = \text{C} \text{H}_3 \text{O} \\
\text{H} - \text{O} = \frac{1}{2} \text{H} \text{O} \\
\text{H} - \text{O} - \text{H} \\
\text{H} = 0
\]

Ketoaldehydose

\[
\text{CH}_3\text{O} \\
\text{H} - \text{O} = \frac{1}{2} \text{H} \text{O} \\
\text{H} - \text{O} - \text{H} \\
\text{H} = 0
\]

Hexose 1,4-linked to a C3 sugar.

Ketoaldehydose

\[
\text{O} = \text{C} \text{H}_3 \text{O} \\
\text{H} - \text{O} = \frac{1}{2} \text{H} \text{O} \\
\text{H} - \text{O} - \text{H} \\
\text{H} = 0
\]
2. Oligo-saccharides

- Monosaccharides are derivatives of six carbon sugars (6-8 atoms).

Oligo-saccharides are made up of a few monosaccharide units joined together.

- Sucrose, also known as table sugar, is a disaccharide composed of glucose and fructose.

3. Poly saccharides

- Homopoly saccharides are made up of a single monosaccharide unit.

For example, cellulose and starch are homopoly saccharides found in plants.

- Heteropoly saccharides are made up of multiple monosaccharide units.

For example, cellulose, starch, and gums are heteropoly saccharides found in plants.

Disaccharides

- Sucrose is made up of glucose and fructose.

- Maltose is made up of two glucose units.

- Lactose is made up of one glucose and one galactose unit.
Stereoisomers

The three most significant isomers of a molecule are constitutional, geometric, and optical isomers. Constitutional isomers have different structures, geometric isomers have different spatial arrangements, and optical isomers are mirror images of each other.

Geometrical Isomers (cis, trans)

Some molecules have cis and trans isomers, which are mirror images of each other. The term cis refers to the configuration where the groups on the molecule are on the same side, while trans refers to the configuration where the groups are on opposite sides.

Optical Isomers

Optical isomers are mirror images of each other that are not superimposable. They are often found in nature and have different properties. The terms used to describe optical isomers are D and L, which represent the absolute configuration of the molecule.
Lipids

The lipids are a heterogeneous group of compounds including fats, oils, steroids, waxes, and related compounds.

* Lipids are a major source of energy for the body.

* Common properties of lipids:
  1. Relatively insoluble in water
  2. Soluble in nonpolar solvents such as ether and chloroform.
  3. Important dietary constituents because of their high energy value and constituents of fat-soluble vitamins.

* Fats are stored in adipose tissue, where it also serves as a thermal insulator.

* Combinations of lipid and protein (LipoProteins) are important cellular constituents, occurring both in the cell membrane and in the mitochondria.

* Knowledge of lipid biochemistry is necessary in understanding many important biomedical areas, e.g., obesity, diabetes mellitus, atherosclerosis.

* Lipids are classified as simple or complex:

  1. Simple lipids: Esters of fatty acids with various alcohols.
     a. Fats: Esters of fatty acids with glycerol. Oils are fats in the liquid state.
     b. Waxes: Esters of fatty acids with higher molecular weight monohydric alcohols.

\[
\begin{align*}
&\mathrm{CH}_2-\mathrm{O}^\ominus \quad \mathrm{C}^\ominus \quad \mathrm{R}_1 \\
&\mathrm{CH}_2-\mathrm{O}^\ominus \quad \mathrm{C}^\ominus \quad \mathrm{R}_2 \\
&\mathrm{CH}_2-\mathrm{O}^\ominus \quad \mathrm{C}^\ominus \quad \mathrm{R}_3
\end{align*}
\]

  Triacylglycerol (Triglycerides)

\[
\begin{align*}
&\text{Fatty acids}
\end{align*}
\]

\[
\begin{align*}
&\text{Choline} \\
&\text{Phospholipids} \\
&\text{Steroids}
\end{align*}
\]
2. Complex lipids: Esters of fatty acids containing groups in addition to an alcohol and a fatty acid,
a. Phospholipids: Lipids containing, in addition to fatty acids and an alcohol, a phosphoric acid residue.
b. Glycolipids (glycosphingolipids): Lipids containing a fatty acid, sphingosine, and carbohydrate.
c. Other complex lipids: Lipids such as sulfolipids and aminolipids. Lipoprotein may also be placed in this category.

3. Precursor and derived lipids: These include fatty acids, glycerol, esteroids, other alcohols, fatty aldehydes, and ketone bodies.

* Because they are uncharged, acylglycerols (glycerides), cholesterol and cholestereolessters are termed neutral lipids.

* Fatty acids are all long carbonic carboxylic acids:

Fatty acids occur mainly as esters in natural fats and oils, but do occur in the unesterified form as free fatty acids, a transport form found in the plasma.

Fatty acids are usually straight-chain derivatives. The chain may be saturated (containing no double bonds) or unsaturated (containing one or more double bonds).

\[
\begin{align*}
R & \quad C = O \\
\text{Carbohydrate} & \quad O - CH_2 - C - OH & \quad \text{OH} \\
\text{Glycolipid} & \quad \text{HHH} & \quad \text{HHH}
\end{align*}
\]

* Fatty acid consists of a hydrophobic hydrocarbon chain with a terminal carboxyl group (-COOH) which ionize to -COO\(^{-}\). This anionic group has an affinity for water, giving the fatty acid its amphipathic nature, having both a hydrophilic and hydrophobic
FFA = Free Fatty Acid
Fatty acids exist free in the body (that is, they are unesterified), and are also found as fatty acyl esters in more complex molecules.
* Plasma free fatty acids transported by serum albumin to their site of consumption (most tissues). Also FFA can be oxidized by many tissues particularly liver and muscle to provide energy.
* Fatty acids are also structural components of membrane lipids, such as phospholipids and glycolipids.
* Fatty acids are also precursors of the hormone-like prostaglandins (polyunsaturated fatty acid with 20 carbons) that have a wide range of responses, both physiologic and pathologic.
* Esterified fatty acids, in the form of triacylglycerols stored in adipose cell, serves as the major energy reserve of the body.
* More than 90% of FA found in plasma are in the form of fatty acid esters (primarily triacylglycerol, cholesterol esters, and phospholipids) contained in circulating lipoprotein particles.
* Fatty acid chains may contain no double bonds - that is be saturated or contain one or more double bonds - that is be more- or polyunsaturated.

when double bonds are present, they are nearly always in the cis rather than in the trans Confg. The introduction of cis-double bond causes the fatty acid to bend.

- Saturated bond
- Unsaturated bond
- Cis config.
**Some Fatty acids of Physiologic importance**

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Structure</th>
<th>Essential FA</th>
<th>Producers of Prostaglandins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formic acid</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetic acid</td>
<td>2:0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propionic acid</td>
<td>3:0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butyric acid</td>
<td>4:0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caprylic acid</td>
<td>10:0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palmitic acid</td>
<td>16:0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palmitoleic acid</td>
<td>16:1(9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oleic acid</td>
<td>18:1(9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linoleic acid</td>
<td>18:2(9,12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\alpha)-Linolenic acid</td>
<td>18:3(9,12,15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arachidonic acid</td>
<td>20:4(5,8,11,14)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Double bonds between carbons are numbered from carboxyl carbon.*

![Arachidonic Acid Diagram]

The carbon of the terminal methyl group is called the \(\omega\)-carbon regardless of the length of the chain length.

© Two fatty acids are dietary essentials in humans: Linoleic acid, which is the precursor of arachidonic acid, the substrate of Prostaglandin synthesis, and \(\alpha\)-linolenic acid the precursor of other \(\omega-3\) fatty acids important for growth and development. Omega-3 fatty acids are especially essential in people with diabetes. 
Synthesis of fatty acids:

In adult humans, fatty acid synthesis occurs primarily in the liver and lactating mammary glands. The process incorporates carbons from acetyl-CoA into growing fatty acid chains, using adenosine triphosphate (ATP) and reduced nicotinamide adenine dinucleotide phosphate (NADPH).

The first step in FA synthesis is the transfer of acetyl units (which are produced by dehydrogenation of pyruvate) from mitochondrial acetyl-CoA to the cytosol. This process is catalyzed by pyruvate dehydrogenase (PDH) complex.

Acetyl-CoA

Pyruvate

\[ 	ext{Acetyl-CoA} + 	ext{NAD}^+ \rightarrow \text{CO}_2 + \text{CO}_2 + \text{NADH} + \text{H}^+ \]

Translocation of citrate from the mitochondrial matrix to the cytosol to produce cytosolic acetyl-CoA because Acetyl-CoA cannot cross the mitochondrial membrane.

\[ 	ext{OAA} \rightarrow 3\text{CO}_2 - \text{C} - \text{CO}_2 + \text{CO}_2 \]

Citrate synthase

\[ 	ext{Citrate} \rightarrow \text{H}_2\text{O} + \text{CoA} \]

Citrate

\[ \text{Citrate} \rightarrow \text{OAA} \]

OAA

Mitochondrial matrix

Oxaloacetate

Acetyl-CoA

Citrate

Citrate synthase

Cytosol

ATP-citrate lyase

OAA

Acetyl-CoA

ATP

ADP + Pi
This carboxylation of acetyl-CoA to form malonyl-CoA is both rate-limiting and regulated step in fatty acid synthesis. 

**Compound Lipids**

*Phospholipids*: are polar, ionic compounds composed of an alcohol that is attached by phosphodiester bridge to either diacylglycerol or sphingosine. Like fatty acid phospholipids are amphipathic in nature, that is, each has a hydrophilic head (the phosphate group plus whatever alcohol is attached to it, for example serine, ethanolamine, and choline), and hydrophobic tail (containing fatty acid or fatty acid derivative).
Saponification: lipids that undergo alkaline hydrolysis

Nonsaponifiable lipids: lipids that do not undergo alkaline hydrolysis

Saponification Value: number of mg of KOH that saponifies one gram of fat or oil or fatty acid:

Saponification reaction:

\[ \text{CH}_3 (\text{CH}_2)_x - \text{COOH} + \text{KOH} \rightarrow \text{CH}_3 (\text{CH}_2)_x - \text{COOK} + \text{H}_2\text{O} \]

F.A.

Sapon: oils and fats are boiled with NaOH until the liquid wax hydrolyzes. Then water was added to separate the sapon.

The type of sapon depends upon the kind of F.A. used.

* Unsaturated fatty acids:

F.A. contain one or more double bonds and cannot be saturated with halogens and hydrogens

a. F.A. with one double bond like oleic and 18:1 (9)

\[ \text{CH}_3 \quad (\text{CH}_2)_7 \quad \text{CH} = \text{CH} - \text{COOH} \]

b. F.A. with two double bonds like linoleic and 18:2 (9, 12)

\[ \text{CH}_3 \quad (\text{CH}_2)_7 \quad \text{CH} = \text{CH} - \text{CH} = \text{CH} - \text{COOH} \]
c. F.A. with three double bonds \( \text{like linolenic acid} \)
\[ 18:3(\alpha, \beta, \gamma) \]
d. F.A. with four double bonds \( \text{like Arachidonic acid} \)
occurs in composition of Leukotriene and Cephalin that's found in liver and brain and cell membrane, and it's important for prostaglandin synthesis

\[
\begin{array}{c}
\text{Arachidonic acid} \\
20:4(\Delta 5, \Delta 8, \Delta 11, \Delta 14)
\end{array}
\]

Oleic acid is the abundant F.A. in animal and plants fats -- more of saturated F.A. that enter the body with diet, the body convert it to unsaturated F.A. (Oleic acid) only.

Fats that store in the body stored as saturated form

Fats that contain unsaturated F.A. called oils \( \text{sun} \) and its in liquid form -- and can converted to solid fats by hydrogenation.
1. Lipoic acid: a derivative from caprylic acid (C8:0) containing two groups of sulfhydryl -SH and its from vitaminine and plays an important role in acyl radical transfer in enzymic system.

\[
\text{CH}_2-\text{CH}_2-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}-\text{COOH} \\
\text{SH} \quad \text{SH}
\]

2. Prostaglandin (PG): fatty acid with 20 carbon atoms.

\[
\text{CH} = \text{CH}-\text{CH}-(\text{CH}_2)_4-\text{CH}_3 \\
\text{OH}
\]

PG extracted from prostate, (the name come from this) and play an important role as body hormone. It's stopped lipolysis that catalyzes by adrenalin and thyroid.

There are several types of prostaglandins.
Waxes

Esters of F.A with some of monohydroxyl alcohols and its long chain like myricyl alcohol

\[ \text{C}_13\text{C}_7\text{H}_2)_{29}\text{OH} \rightarrow \text{Lauryl C}_13\text{C}(\text{CH}_2)_{11}\text{OH} \]

Myricyl stearate = That did not dissolve

\[ \text{C}_13\text{C}(\text{CH}_2)_{11}\text{O}-\text{C}(\text{CH}_2)_{16}\text{C}_13 \]

in water but can dissolve in organic solvents and cannot digest by enzymes of fats, and did not have any role in diet

22 CP 27 CP