Other Lipids

Essential Oils (Volatile Oils): They are found in various organs of plant cells, and especially in specialized secretory glands. They evaporate without leaving a trace when dripped on paper. They are obtained by hydrodistillation, they are mostly in liquid form and have pleasant odor. therefore, they are also known as essences and are being used in perfumery and cosmetics industry.

Some of the families that are rich in essential oils:

1. Myrtaceae
2. Labiatae (Lamiaceae)
3. Lauraceae
4. Rutacaeae
5. Rosaceae
6. Geraniaceae
7. Umbelliferae (Apiaceae)
8. Pinaceae

Essential oils can be found in the cells of organs like leaves, flowers, stems, rhizomes, fruits, seeds in secretory structures like oil glands (oil pockets or secretory cavities) and in oil channels.

Functions of essential oils in plants are:

- **thermoregulation**
- **prevention of water loss**

According to another classification, lipids are divided into three groups as:

Triglycerides

Phospholipids

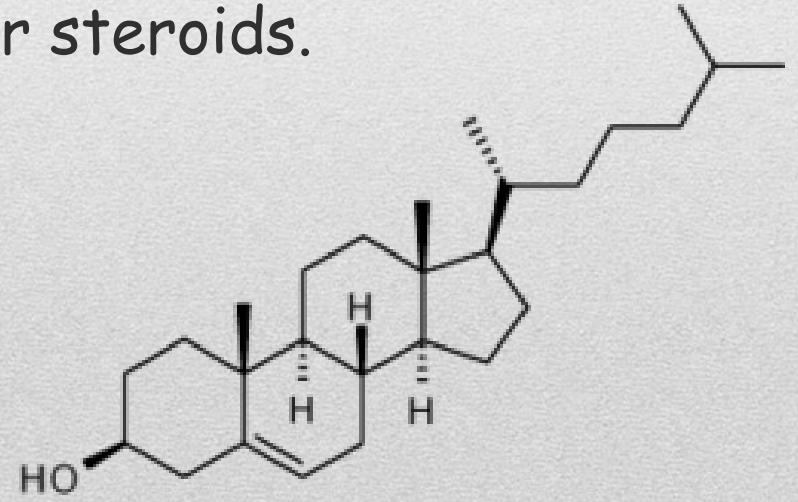
Steroids

1) Triglycerides: Neutral lipids that are used as the main fuel source in animal tissues. Foodstuff that are consumed in excess are converted into triglycerides and stored in various lipid tissues in the form of oil drops to be used when the body needs them. When the body needs them, they are hydrolyzed into free fatty acids with a hormonal stimulus and then oxidized and transported to the liver and the muscles with blood circulation to provide energy.

2) Phospholipids: Contribute to the structure of cell membrane and form the essential component. Phosphoric acid and a base containing nitrogen are also present with glycerol and the fatty acid. The part containing the phosphorus and the nitrogen makes the phospholipid molecule polar. Therefore, this part has hydrophilic property. The tai is hydrophobic and repels water and is found in the middle of the bilayer lipid structure. Since these two opposite properties are found in the same molecule, they have the ability to dissolve both in the water and in organic solvents.

3) Steroids: They are formed of 4 interwoven rings made up of C, H and O atoms. They dissolve in lipids and also in alcohol, chloroform and acetone. Vitamin D, male and female sex hormones, adrenal cortical hormones, bile salts and cholesterol are examples for steroids.

Cholesterol: It is found in the structure of animal cell membrane, in the nerves tissue and in other tissues as construction material. They are not found in plant tissues. They accumulate in the membranes of skin cells along with lipids and increase the resistance of the skin to acids and dissolving substances, prevent water loss in the skin. It is also a starting material for other steroids.



In vertebrates, cholesterol consumed with foodstuffs or synthesized in the body are converted into other steroid groups. Bile salts are among these groups; they are formed in the liver and transported to the intestine via bile ducts and there they function in the digestion and absorption of lipids. Another sterol formation occurs in the endocrine organs. For example, cholesterol in converted into cortisol and aldosteron in the adrenal gland; converted to estrogen in the ovaries; converted into androgen in the testicles and into progesterone in the corpus luteum.

With the elevation of cholesterol level in the blood, a disorder called atherosclerosis forms. In this disorder plaques are formed within the vessels and the vessel diameter is narrowed and loses its flexibility.

OXIDATION OF LIPIDS AND PROTEINS

Oxidation of Lipids

Lipids consumed with foodstuff are first emulsified in the small intestine with **bile acid salts** into droplets and then digested and hydrolyzed with the **lipase** enzyme from pancreas into **glycerol** and **fatty acids**. Then they are absorbed by the intestines and some of them are transported to the **lymph** system and by this way they mix with blood. Fatty acids having less then 12 carbon atoms and their triglycerides are transported to the **liver** vis vena cava and then to **systemic circulation**.

When absorbed lipids reach the blood, a white turbidity is seen in the plasma. And some of the lipids that enter the blood circulation by both of these ways **go to the liver, some penetrate into other tissues** and **some are stored in adipose tissue**. Stored lipids maybe used when the body needs energy.

Lipids that are broken down as fatty acids and glycerol has to pass through the **Krebs cycle** if they are to be used to obtain energy. Thus, fatty acids first combine with **CoA** and become activated and form **Acetyl-CoA**. Then this Acetyl-CoA turns into acetic acid, enter into Krebs cycle, become oxidized and provide energy to the organism.

Glycerol molecule with 3 C atoms first turns into PGAL (phosphoglyceraldehyde), then **PGA** (**phosphoglyceric acid**) and finally into **pyruvic acid**. **Pyruvic acid** loses 1 CO_2 and the remaining substance having 2 C atoms combine with CoA and form the **Acetyl-CoA**. After that in turns into acetic acid having 2 carbon atoms, go into Krebs cycle and provide energy.

For example, **131 ATP** is obtained from the oxidation of **palmitic acid**.

Since fatty acids and amino acids have different number of carbon atoms, they yield different amounts of ATP, H_2O and CO_2. E.g.: Fatty acids contain less oxygen (O_2) and more hydrogen (H) atoms. Therefore, as a result of cellular respiration they form **less CO_2, more H_2O**. (they are good source of water for animals living in arid environment).

Oxidation of Proteins

Proteins have C, H, O, N, S and P in their structures and are formed of amino acids. An amine group (NH_2) and a carboxyl group (COOH) is found in an amino acid. Carboxyl groups give acids property and the amine group give basic property. Two amino acids form a peptide bond with the extraction of water. This bond forms between the amine group of one of the amino acid and with the carboxyl group of the other.

Variety of amino acids is due to the additional groups that can be found along with the carboxyl and amine groups. These additional groups have different structures. Molecular weights of amino acids vary between 5.000 and a couple of millions.

They can be grouped as:

- Aliphatic aa: Gly, Ala, Val, Leu, İleu
- Hydroxylic aa: Ser, Thr
- Acidic aa: Asp, Glu
- Amids: Asn, Gln
- Basic aa: His, Lys, Arg
- Sylphur containing aa: Cys, CysSH, Met
- Aromatic aa: Phe, Try, Trp
- Imino aa: Pro

(Gly: Glycine, Ala: Alanine, Val: Valine, Leu: Leucine, Ileu: Isoleucine, Ser: Serine, Thr: Threonine, Asp: Aspartic acidt; Glu: Glutamic acid, Asn: Asparagine; Gln: Glutamine; His: Histidine, Lys, Lysine; Arg: Arginine, Cys: Cysteine, Met: Mehtionine, Phe: Phenlyalanine, Try: Tyrosine, Trp: Triptophane, Pro: Proline)

They are absolutely necessary for the survival of living beings. Since protein synthesis is performed under the control of genes, all living beings have different proteins. Proteins are first hydrolyzed into the amino acids that they are formed of, and then enter into blood circulation as a result of digestion. Though most of the proteins preserved their biological activities at a certain pH and temperature, when they are heated to 60-80°C, they precipitate. This is called **denaturation** and the biological activity of that protein is completely corrupted. Denaturation might be reversible in some cases and the protein may regain is activity and this is called **renaturation**.

Biological functions of proteins:

- They are important components of the cell membrane and endomembranes.
- They have structural functions in the muscles and in the connective tissues.
- They have role in the transportation of O_2 with hemoglobin and electrons with cytochromes and also in the transportation of some substances in the cell membranes.

- They regulate electrolyte balance in which albumin is effective in.
- They function in the catalyzation of anabolic and catabolic reactions by enzymes and hormones.
- Immunoglobulins (antibodies) formed by the plasma cells protect the organism against antigens.
- They have role in the growth and reproduction of the living being and also in the transferring of genetic properties to the next generation.
- They provide muscle contraction i.e. mobility to the organism.

The energy obtained by oxidizing 1 molecule of protein is more than the energy provided by carbohydrates and less than the energy provided by the lipids. 9.1 kilocal/g energy from lipids, 4.8 from proteins and 3.8 from carbohydrates.

Proteins are used in the cell as fuel as the last stage since proteins provide structural components and the enzymes. They are broken down into **amino acids** with the enzyme **proteinase**, then amine groups are removed by **aminase** enzyme and the resulting material enter into Krebs cycle.

The role of acetyl-CoA:

Acetly CoA is an important intermediate in the oxidation of various essential substances. Carbohydrates, lipids and some proteins combine with CoA and form Acetyl-CoA before entering into Krebs cycle.

2. Anaerobic Respiration (Fermentation)

This type of respiration takes place without the presence of oxygen, so oxygen does not work as the last electron receiver. The reactions of the electron carrying system end when all intermediates are reduced and all available electrons are received.

Fermentation takes in place in rather primitive organisms; in **yeast fungi** (pyruvate turns into ethyl alcohol in yeast cells = Alcoholic fermentation) and in **bacteria** (pyruvic acid turns into lactic acid without oxygen in the muscle cells of sophisticated animals or in lactic acid bacteria (Lactate fermentation)).

The energy obtained is only **2 ATP**, however it is enough for the organism to survive. Since free oxygen was not present in the primitive atmosphere, organisms performed fermentative respiration and succeeded to survive with this small amount of energy.

If we compare anaerobic and aerobic respiration, the stages till the formation of pyruvic acid occurs the same and as a result net **36-38 ATP is obtained in aerobic respiration**; and **net 2 ATP is obtained in anaerobic respiration.**

If oxygen is not found in the environment, then the last hydrogen receiver is not oxygen, it is something else. Therefore, the final product in fermentation is:

- **Lactic acid with 3 C atoms** ($C_3H_6O_3$) in animal cells,
- **Alcohol or acetic acid** in plant cells according to the type of fermentation.

In this kind of respiration, ATP is not formed between pyruvic acid and the final product. He energy formed (2 ATP) is formed during the **glycolysis** stage.

Fermentation is very important in respect to industry and also in our daily lives. With fermentation we are able to produce alcohol, vinegar, pickles, yoghurt, cheese, kephyr, kumiss. Yeast fungi have an important role in alcohol fermentation.

Fermentation types in plant and animal cells:

1) Lactic acid fermentation:

Occurs in animal cells. When sufficient amount of oxygen is not present in tissues, especially in muscle tissues, $NADH+H^+$ gives 2 H atoms to pyruvic acid and lactic acid is formed. If lactic acid accumulates in the muscle, muscle fatigue forms. The energy obtained as a result of this reaction is only 18 calories. If the tissue is provided with enough amount of oxygen O_2, lactic gives the H atoms that it has taken before and turns back into pyruvic acid. This pyruvic acid goes into Krebs cycle and is broken down to $CO_2 + H_2O$.

2) Alcohol fermentation

CO_2 is removed from pyruvic acid with the help of Co-carboxylase enzyme and acetaldehyde is formed. Acetaldehyde takes 4 H atoms from NADH + H^+ and reduced, and thus alcohol forms. During this process 2 NAD^+ molecules are released. Alcohol and CO_2 are the final products in the fermentation performed by yeast cells. The energy obtained is 56 kilocal/moles.

3) Acetic acid fermentation:

CO_2 is removed from pyruvic acid with the help of Co-carboxylase enzyme and acetaldehyde is formed. Acetaldehyde is then combined with water and acetaldehyde hydrate is formed. Finally, acetaldehyde hydrate is oxidized with dehydrogenase enzyme and loses 2 H atoms, and acetic acid with 2 C atoms form.

Common properties of aerobic and anaerobic respiration

- ATP is used.
- The energy found in the chemical bonds of organic molecules are transferred to ATP molecule.
- CO_2 is formed (except for lactic acid fermentation)