Biology

Topic: lipids

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▪ Lipids are the one class of large biological molecules that does not include true polymers and they are generally not big enough to be considered macromolecules.

▪ Lipids consist mostly of hydrocarbon regions

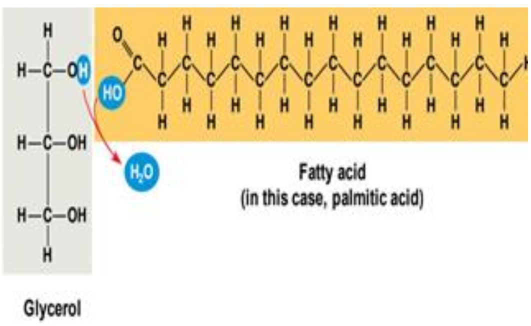
▪ The unifying feature of lipids is that they mix poorly, if at all, with water

▪ The most biologically important lipids are **fats, phospholipids, and steroids**

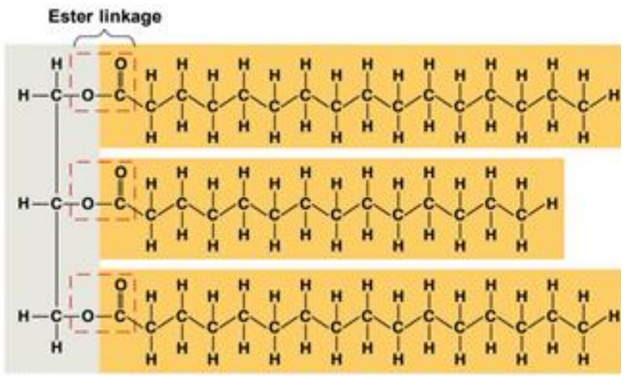
❖ Fats and oils

- Fats are also called triacylglycerol, or triglyceride

- A fat molecule consists of two main components: **1. Glycerol** **2. Three fatty acids**



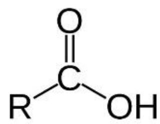
(a) One of three dehydration reactions in the synthesis of a fat



(b) Fat molecule (triacylglycerol)

- Glycerol is an organic compound (alcohol) with **three carbons**, **five hydrogens**, and t**hree hydroxyl (OH) groups**.

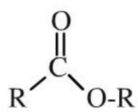
- Fatty acids have a long chain of hydrocarbons to which a **carboxyl group** attached



- The number of carbons in the fatty acid may range **from 4 to 36**.
- The most common are those **containing 12–18 carbons**.

- In a fat molecule, the **fatty acids** attach to each of the **glycerol** molecule's three carbons with an **ester bond** through an oxygen atom

- Esters feature a carbon-to-oxygen double bond that is also singly bonded to a second oxygen atom.



- During this ester bond formation, **three water molecules are released**.

- The three fatty acids in the triacylglycerol may be **similar or dissimilar**.

- Fatty acids may be **saturated or unsaturated**:

➔ if there are only single bonds between neighboring carbons in the hydrocarbon chain, the fatty acid is **saturated.**

➔ **Saturated** fatty acids are saturated with hydrogen.

➔ The number of hydrogen atoms attached to the carbon skeleton is maximized.

➔ Stearic acid is an example of a saturated fatty acid

➔ Most unsaturated fats are liquid at room temperature. We call these oils.

➔ If there is one double bond in the molecule, it is a monounsaturated fat (e.g., olive oil),

➔ if there is more than one double bond, then it is a polyunsaturated fat (e.g., canola oil).

➔ When a fatty acid has no double bonds, it is a saturated fatty acid because it is not possible to add more hydrogen to the chain's carbon atoms.

➔ Long straight fatty acids with single bonds generally pack tightly and are **solid** at room temperature.

➔ Mammals store fats in specialized cells, or **adipocytes**

➔ Plants store fat or oil in many **seeds** and use them as a source of energy during seedling development.

- **Cis and trans fats**

- Unsaturated fats or oils are usually of **plant origin** and contain **cis unsaturated fatty acids.**

- Cis and trans indicate the configuration of the molecule around the double bond.

- If hydrogens are present in the same plane, it is a **cis fat.**

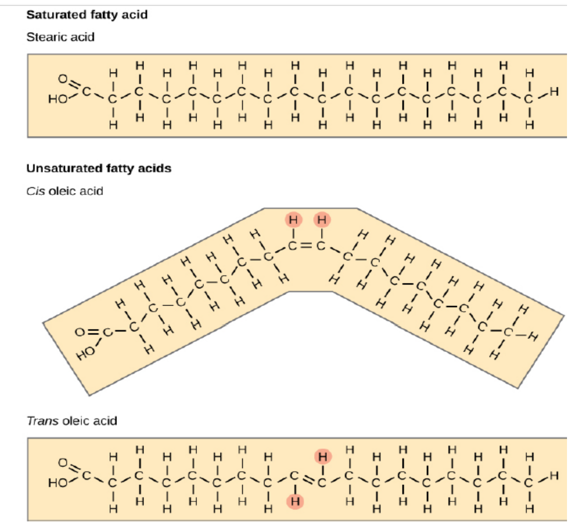
- If the hydrogen atoms are on two different planes, it is a **trans fat**.

- The cis double bond causes a bend or a "kink" that prevents the fatty acids from packing tightly, keeping them liquid at room temperature

- Unsaturated fats help to lower blood cholesterol levels

- Saturated fats contribute to plaque formation in the arteries.

- **Hydrogenation** of unsaturated oil takes place in light industries to form trans double bonds and the oil is converted to solid form.



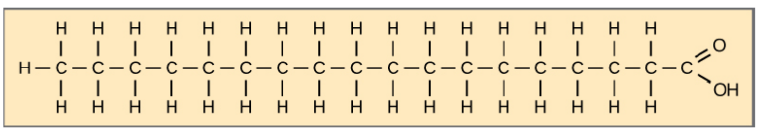


Figure 3.14 Stearic acid is a common saturated fatty acid.

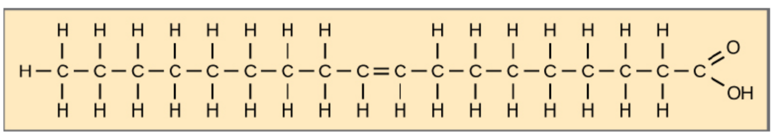


Figure 3.15 Oleic acid is a common unsaturated fatty acid.

❖ Phospholipids

- Consists of:

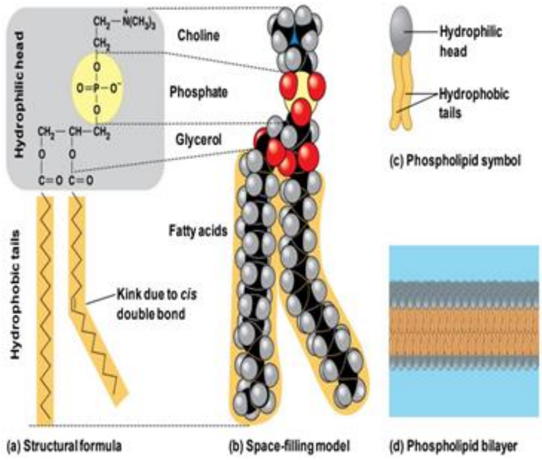
1. glycerol **2. two fatty acids** (hydrophobic) **3. Phosphate group** (hydrophilic)

- Phospholipids are major plasma membrane constituents that comprise cells' outermost layer.
- Two fatty acids forming **diacylglycerol**, and a modified **phosphate group**
- A phosphate group alone attached to a diacylglycerol➔ **phosphatidate**.

- Phospholipids It is:

1. phosphatidate (diacylglycerol 3-phosphate), the precursor of phospholipids.
2. An alcohol modifies the phosphate group.

- Two important phospholipids that are in plasma membranes:
1) Phosphatidylcholine
2) Phosphatidylserine



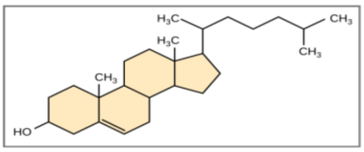
- A phospholipid is an **amphipathic** molecule, meaning it has a hydrophobic and a hydrophilic part.

- The fatty acid chains are **hydrophobic** and <u>cannot interact with water</u>; whereas, the phosphate-containing group is **hydrophilic** and <u>interacts with water</u>

- The head is the hydrophilic part
- tail contains the hydrophobic fatty acids.

- In a membrane, fatty acid tails face inside, away from water; whereas, the phosphate group faces the outside, aqueous side forming a bilayer

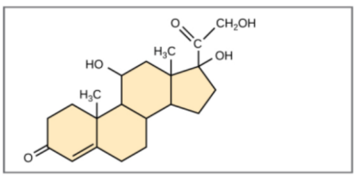
❖ steroids



Cholesterol

- Steroids have a fused ring structure.

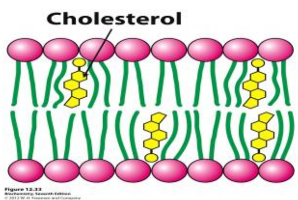
- Although they do not resemble other lipids steroids are hydrophobic and insoluble in water.



Cortisol

- All steroids have four linked carbon rings and several of them, like cholesterol, have a short tail.

- Many steroids also have the –OH functional group, which puts them in the alcohol classification (sterols).



- In human body many hormones are steroids (testosterone, progesterone, and glucocorticoids).

- Cholesterol found also in the cell membrane.