Lipids and Their Structures

Definition: Organic molecule of biological origin that is insoluble in water and soluble in nonpolar solvents.

Solubility Explained: Lipids do have both nonpolar and polar regions; however, the majority of the molecule is nonpolar (due to large nonpolar tails). Since "like dissolves like", lipids are soluble in nonpolar solvents.

There are eight general categories of lipids, but I will only go into seven (fatty acids, waxes, triacylglycerides, phospholipids, prostaglandins, steroids, and lipophilic vitamins)

Fatty Acids (Function: Precursor to other lipids.)

Structure: Carboxylic acid and long, unbranched hydrocarbon chain

- Most have an even number of carbons
- Most common: 12-20 carbons
- May or may not have pi bonds in the chain (saturated- no C=C and unsaturated- 1+ C=C)
- Saturated fatty acids are not too fancy, don't over complicate them. Check out these examples to see the extremely small differences between them.

**Saturated fatty acids**

Lauric acid (12 C)  
Myristic acid (14 C)  
Palmitic acid (16 C)  
Stearic acid (18 C)  
Arachidic acid (20 C)
• Within unsaturated fatty acids are divided into monounsaturated fatty acids (one C=C bond) and polyunsaturated fatty acids (more than one C=C bond)

• Unsaturated fatty acid structures are a little more complicated, but you can see a pattern in the important structure (besides arachidonic acid). Try and familiarize yourself with the pattern.

Waxes (Function: Water barrier)

Structure: Esters with long hydrocarbon chains on both sides of the ester (with the =O in the middle)

• Derived from a fatty acid and a long-chain alcohol

Cerotic acid
A fatty acid

Myricyl alcohol
Long chain alcohol

Myricyl cerotate
Present in beeswax, carnauba wax
**Triacylglycerides** (Function: Energy Storage)

Structure: Fatty acid triester of glycerol

They are call fats if solid at room temperature and oils in they are liquids

The structure is easy to remember if you just think in steps:
- remove the alcohols from the glycerol
- remove the hydrogen (of the carboxylic acid) from each fatty acid
- bond the oxygen with now three lone pairs on it to one of the three outside carbons.
- Now you have a triacylglyceride.

**Phospholipids** (Function: Cell membrane)

Structure: Glycerol esterified with two fatty acids and one phosphate group

Phospholipid structure is very easy to grasp if one has already grasped the structure of a triacylglyceride. I would recommend making sure you grasp that
first before you try to grasp phospholipids because it makes it much simpler to comprehend.

- A sign that it is a phospholipid is the fatty acids are usually palmitic, stearic, and/or oleic acid. This isn't always the case, but it can help you determine if it is a phospholipid.
- To get the structure of a phospholipid:
  - take the structure of a triacylglyceride
  - remove one fatty acid
  - replace it with a phosphate
  - Now you have a phospholipid

**Prostaglandins** (Function: Regulators and signal molecules)

**Structure:** A prostanoic acid skeleton

[Diagram of prostanoic acid]

- For structure all you should know is the structure of a prostanoic acid and that the name changes based on the number of OH, C=O, and C=C groups.
- This tutorial is focused on structure, but for prostaglandins there are a lot of functions that are important and I recommend you know them.

**Steroid** (Function: Each steroid has a variety of functions)

**Structure:** A ring system of three adjacent cyclohexanes and a cyclopentane.

[Diagram of steroid]
• This ring system is approximately flat while the other components are not limited to being flat or not.
• To understand the structure of steroid, one must look at the steps of steroid biosynthesis. Specifically we are going to observe the process of changing acetyl CoA to cholesterol.

Lipophilic Vitamins (Functions: Broad range of functions)

Structure: Broad range of structures

• There are a broad range of structures for lipophilic vitamins, but we only go into three vitamins: Vitamin E, Vitamin C, and Vitamin A.
• Just familiarize yourself with these structures.
• There really isn't a trick to these structures so just do a lot of practice problems involving these and you will get the hang of it.
Vitamin E protects against radicals

\( \alpha \)-Tocopherol

*Hydrophobic antioxidant vitamin*

- Vitamin E protects against radicals

Vitamin C (ascorbic acid)

*Hydrophilic antioxidant vitamin*

- Vitamin C is a antioxidant

Vitamin A (retinol)

- Vitamin A is essential to vision
Works Cited:


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