

Chapter 5-3: Lipids

Lipids – Diverse Hydrophobic Molecules

- Lipids are an exception among macromolecules because they *do not have polymers*.
- The unifying feature of lipids is that they all have *little or no affinity for water - hydrophobic*.
 - This is because their structures are dominated by non polar covalent bonds.
- Lipids are highly diverse in form and function.
 - Fats store large amounts of energy**
- A **fat** is constructed from two kinds of smaller molecules, *glycerol and fatty acids*.
- **Glycerol** consists of a three carbon skeleton with a hydroxyl group attached to each.
- A **fatty acid** consists of a carboxyl group attached to a long carbon skeleton, often 16 to 18 carbons long.

- The many non polar C-H bonds in the long hydrocarbon skeleton make fats hydrophobic.

- In a fat, three fatty acids are joined to glycerol by an ester linkage (*a bond between a hydroxyl group and a carboxyl group*), creating a **triacylglycerol**.

- The three fatty acids in a fat can be the same or different.
- Fatty acids may vary in length (number of carbons) and in the number and locations of double bonds.
 - No carbon-carbon double bonds - molecule is a **saturated fatty acid** - a hydrogen at every possible position.
 - One or more carbon-carbon double bonds - molecule is an **unsaturated fatty acid** - formed by the removal of hydrogen atoms from the carbon skeleton.
 - Saturated fatty acids are straight chains
 - Unsaturated fatty acids have a kink wherever there is a double bond.

- Saturated Fats:
 - Most animal fats are saturated.
 - Saturated fat are solid at room temperature.
 - May contribute to cardiovascular disease (atherosclerosis) through plaque deposits.
- Unsaturated Fats:
 - Plant and fish fats, known as oils
 - Are liquid at room temperature.
 - Kinks provided by the double bonds prevent the molecules from packing tightly together.

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- The major function of fats is energy storage.
 - A gram of fat stores more than ***twice as much energy*** as a gram of a polysaccharide.
 - Plants use starch for energy storage when mobility is not a concern but use oils when dispersal and packing is important, as in seeds.
 - Humans and other mammals store fats as long-term energy reserves in adipose cells.
- Fat also functions to cushion vital organs.
- A layer of fats can also function as insulation.
 - This subcutaneous layer is especially thick in whales, seals, and most other marine mammals.

Phospholipids are major components of cell membranes

- **Phospholipids** have two fatty acids attached to glycerol and a phosphate group at the third position.
 - The phosphate group carries a negative charge.
 - Additional smaller groups may be attached to the phosphate group.
- The interaction of phospholipids with water is complex.
 - The fatty acid tails are hydrophobic, but the phosphate group and its attachments form a hydrophilic head.
- At the surface of a cell phospholipids are arranged as a bilayer.
 - The hydrophilic heads are on the ***outside*** in contact with the aqueous solution and the hydrophobic tails form the core.
 - The ***phospholipid bilayer*** forms a barrier between the cell and the external environment.
- They are the major component of membranes.

Steroids include cholesterol and certain hormones

- Steroids are lipids with a carbon skeleton consisting of four fused carbon rings.
 - Different steroids are created by varying functional groups attached to the rings.
- Cholesterol, an important steroid, is a component in animal cell membranes.
- Cholesterol is also the precursor from which all other steroids are synthesized.
 - Many of these other steroids are hormones, including the vertebrate sex hormones.
- While cholesterol is clearly an essential molecule, high levels of cholesterol in the blood may contribute to cardiovascular disease.