3: LIPIDS (part 1)

A fatty acid is a carbon chain with the COOH carboxyl group attached to one end. In this lesson we will see how fatty acids can be attached to a larger molecule, called glycerol.

Glycerol is a carbon-based structure, with a chain of 3 carbons at the center. The presence of 3 oxygen atoms makes it different from the carbon structures we saw in the previous lesson. Think of glycerol as a hanger, from which one, two, or three fatty acids can hang. The fatty acids hanging down from glycerol usually have from 12 to 20 carbon atoms.

To attach a fatty acid to a glycerol "hanger" you must take the OH off the COOH, leaving just CO. On the glycerol end, a hydrogen, H, is pulled off. The unhappy atoms who have an empty bond site dangling are the carbon on the fatty acid and the oxygen on the glycerol. The carbon and the oxygen and matched up and they bond to each other.

What happens to the OH and the H that were pulled off? They join together quite happily to form a molecule of water, H_20. This does not happen randomly, on its own, however. A little "machine" (an enzyme) does the attaching. As we will see in future lessons, enzymes are like little robots who do only one job. The enzyme at work here was designed to do this one task: join fatty acids to glycerol by popping off OH's and H's. This enzyme has an extremely long name that is almost impossible to remember even for an biochemist, so just knowing that an enzyme in involved is enough information for us.

This process has a name you will need to know; it's called ***dehydration synthesis***. (The word "synthesis" is from the Greek word for "make.") As it turns out, this is a common way of joining two molecules. Pull off an OH and an H and join the "ragged edges" you leave behind, making a water molecule in the process. The name might seem backwards. When we think of dehydration it's usually in the context of water evaporating and disappearing, not being made. Think of the word "dehydration" in this way: "de" means "from," and "hydro" means "water." You are using water to synthesize something. The end product is coming <u>from</u> the process of making <u>water</u>. This process can be reversed, too. Water can be used to separate two molecules. The water is broken into OH and H, and those ions are used to "plug" the ends of the two broken pieces.

A glycerol that has 3 fatty acids hanging on it is called a ***triglyceride***. ("Tri" is Greek for "three.") A triglyceride's fatty acids can be all the same, or they can be very different. Sometimes a glycerol will have only one fatty acid, so it will be called a ***monogylceride***. ("Mono" is Greek for "one.") A glycerol with 2 fatty acids would be a ***diglyceride***. ("Di" is Greek for "two.") Fatty acids that are not attached to a glycerol are called ***free fatty acids***.

Where does glycerol come from? The body can make it from glucuse sugar or it can use glycerols that come from the things we eat (fats from plants or animals). If glycerol needs to be manufactured from glucose, there are specialed enzyme "robots" that will perform this task. If glycerol is taken out of food, there are enzymes for that, too.

If a fatty acid has all the hydrogens it can possible hold, it is called ***saturated***. Saturated fats tend to be solid at room temperature and are most often found in animal products such as meat and butter. An unsaturated fat is a carbon chain that is missing some hydrogens. A place where two hydrogens are missing creates a double bond, which then causes as a slight bend in the chain. If the chain has only one double bond, it is called **monounsaturated**. If it has many double bonds and therefore many bends, it is called ***polyunsaturated***. ("Poly" is Greek for "many.")

Nutritionists are still debating whether it is better to consume saturated or unsatured fats. To complicate matters, there are ***trans fats*** where hydrogens have been artificially added, to break those double bonds, but the hydrogens end up on opposite sides of the molecule. ("Trans" means "across.") The trans fats tend to stick to the insides of our blood vessels and clog them up. Transfat are most often found in desserts and snack foods.

Fatty acids often have strange-sounding names such as myristoleic acid, sapeinic acids, vaccenic acids and caprulic acid. We won't be learning those. Fatty acids that are very common and also have decent names are lauric acid, (a short one with only 12 carbons and found in coconuts and palms), and palmitic acid with its 16 carbon chain (found in palms). Ther is a whole group of fatty acids that all have 18 carbons, though the number of double bonds varies. Stearic acid has not couble bonds so it is completely saturated. It is found in great aboundance in animal fat, particularly in the fat inside bones (which is where it gets its name). Oleic acid has one double bond and is found in great abundance in olive oil. The "ol" at the beginning of each word (olive and oleic) helps us to remember the connection. Linoleic acid has two double bonds in its chain and is found in flax (from which ***lin****en* is made). Alpha-linolenic acid has three double bonds and is found in nuts and seeds. Why all the fuss about double bonds? Those double bonds cause the chain to have bends or "kinks" in it. This alteration of the shape causes it to behave differently in cells.

Omega-3 fatty acids have a double bond starting at the third carbon from the end. ("Omega" means "last"). Omega-6 fatty acids have a double bond starting at the carbon sixth from the end. Our diets should contain more omega-3 fats and less omega-6 fats. Unfortunately, the modern diet has these reversed. Omega-3 fats are found abundantly in fish oil.

Our bodies can make some fatty acids. The ones we must get from food are called Essential Fatty Acids (EFAs).