4: LIPIDS (part 2: phospholipids)

When lipids are joined to phosphate molecules they form a large molecule called a ***phospholipid***. Phospholipids are one of the key building blocks of cells. As we will see in lesson 5, they will form the outside layer of cells, and also of many smaller cell parts called organelles.

A phospholipid molecule is made of a glycerol hanger that is holding on to two fatty acids and a phosphate. A phosphate is made of 1 atom of phosphorus and 4 atoms of oxygen.

Phosphorus can make 5 bonds. (The Periodic Table can help you determine how many bonds an atom wants to make. The atoms in the first column (Li, Na, etc.) all have one extra electron in their outer shell, so they want to make one bond. The second column atoms all have 2 electrons in their outer shell so they are good for 2 bonds. The third column has 3, and so on. Phosphorus is in the fifth column, so it can make 5 bonds.)   Since there are only 4 oxygen atoms in this molecule, one lucky oxygen atom will get a double bond. The other oxygen atoms have one bond with phosphorus, but are also holding on to an extra electron, which will give the molecule an overall electrical charge of negative 3. We can write PO_4^{3-}. This molecule is a ***polyatomic ion***. Simple ions are made of one atom. Polyatomic ions are made of more than one atom.   (By the way, don't let the word "ion" confuse you. It is common for students to have trouble remembering what an ion is. If you think of an ion as broken molecule, that's sort of right. Ions have had electrons added or taken away, ruining their original neutrality.)

The phosphate ion is best explained by looking at phosphoric acid, H_3PO_4. In this molecule, the oxygens have their two bonds, one with phosphorus and one with a hydrogen. Hydrogen atoms, as we have seen, have the bad habit of easily wandering off. When they leave, however, the oxygen atoms insist on keeping the electrons. You'd think that would make a hydrogen want to stay, but no, it goes off as nothing but a proton. (This makes the surrounding environment acidic. That's what acids do — they donate protons.) If all 3 hydrogens are gone, you have a phosphate ion.

One oxygen of the phosphate ion is bonded to the third hanger on the glycerol. One oxygen has a double bond and just sits there. One oxygen hangs off unbonded, and the fourth oxygen is usually attached to another molecule which can be labeled R. An R group is the variable part of a molecule. R could be any one of a number of different options. We don't need to know any specific molecules for R in this case. We will just write an R and leave it at that.

Two of glycerol's hangers are connected to fatty acids. There are many possibilities for what type of fatty acids these might be, but we are going to draw two special fatty acids: **EPA** and **DHA**. EPA stands for **e**icosa**p**entaenoic **a**cid, and DHA stands for **d**ocosa**h**exaenoic **a**cid. (That's why we calle them EPA and DHA. EPA has 20 carbon atoms and 5 double bonds. DHA has 22 carbons and 6 double bonds. The double bonds cause bends that make the molecules look almost like circles. EPA and DHA are especially valuable in some types of cells, such as nerve cells. They seem to have the ability to keep other molecules from getting too tangled. (This will make more sense a few lessons from now when we make membranes.) These fatty acids are found in other places, too, not just in phospholipids. They are important ingredients in messenger molecules, for instance. They help to stop inflammation.

The most important thing to know about a phospholipid molecule is that the head portion is ***hydrophilic*,** or "water loving," and the tails are ***hydrophobic***, or "water hating." This is a hugely important fact in biochemistry.

Carbon is a very flexible atom; besides being able to form long chains, it can also make rings. One of the most basic rings is called benzene. This is not a molecule found in your body (well, hopefully not), but it is a good example of a carbon ring. Carbon rings are often in the shape of a hexagon or a pentagon.

Cholesterol is made of four carbon rings with some extra atoms attached. It is a natural body substance, and as we will soon see, it is found in and around phospholipid molecules. It can tuck in amongst the fatty acid tails. Cholesterol is not a harmful substance; it is a natural and necessary component found in all body cells. Too much of anything can be bad, so, indeed, a very high level of cholesterol is not good for you. On the other hand, too little is not healthy, either.