Making Sugars, Starch and Cellulose

Both **glucose** and **fructose** are a 6 carbon sugars $C_6H_{12}O_6$. See page 5 of our molecular diagrams handout for their shapes. Refer to the second page of the handout entitled “Simplified Molecular Diagrams” (*http://yosemitefoothills.com/Science-1A/Lab-9-MolecularModelIntroduction/SimplifiedMoleculeDiagrams.pdf*) for help understanding the diagrams.

To make them in an open linear structure requires:

6	4-hole carbons
12	1-hole hydrogens
6	2-hole oxygens

To make them in a compact linear structure requires:

5	4-hole carbons
1	3-hold triangular carbon (used for the double bond
12	1-hole hydrogens
5	2-hole oxygens
1	1-hole oxygen

To make them in an open or compact ring structure requires:

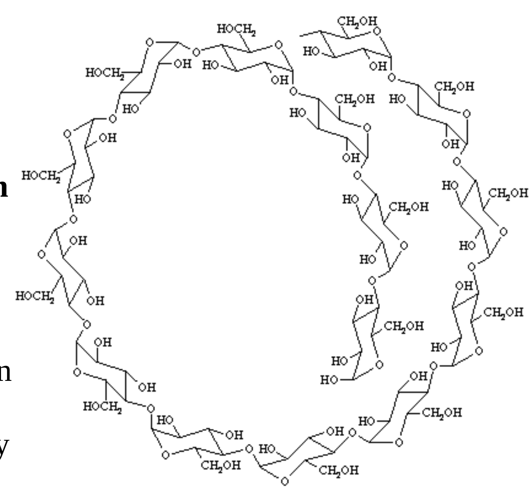
6	4-hole carbons
12	1-hole hydrogens
6	2-hole oxygens

You should make 1 linear D-glucose and 1 linear D-Fructose, then try to fold them into **alpha-D-glucopyranose** and **beta-D-fructofuranose**. This is not easy! You may end up with **beta-D-glucopyranose** and/or the **alpha-D-fructofuranose**.

Notice how the pyranose forms are 6 sided with a “dog-leg” near the ring oxygen and furanose forms are 5 sided with two “dog-legs” on each side of the ring oxygen.

Next join your beta-D-fructofuranose and alpha-D-glucopyranose molecules to produce **sucrose** as shown on page 5 of your molecular diagrams handout. This will free a molecule of water.

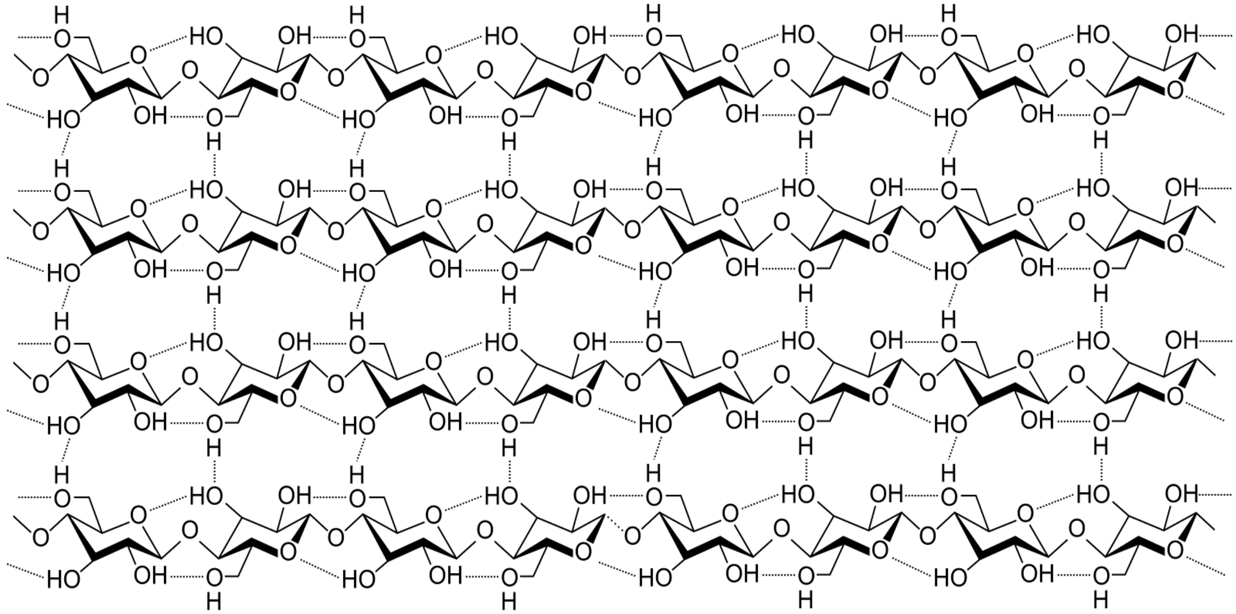
Do not take apart your sucrose and ring glucose versions until the end of the lab. You need them as examples for making the parts for some starch and cellulose discussed below.



As shown on page 6 of our molecular diagrams handout, **Starch** and **cellulose** are both made from chains of glucose molecules, but starch we can eat and cellulose is only food for certain microbes, like those that live inside termites. The difference is that starch is a chain of alpha-D-glucopyranose molecules and cellulose is a chain of beta-D-glucopyranose. Notice also that in starch the glucose molecules have the same orientation, but in cellulose every other one is flipped. The starch chains gradually make a spiral as shown on page 2 of our molecular diagrams handout and in the diagram at the right. In cellulose, the flipping of alternate glucose units straightens out the chain so that cellulose is flat and straight.

Chains of cellulose are strengthened by hydrogen bonds within the chains and with adjacent chains as shown in the diagram below where the hydrogen bonds are shown as dashed lines.

We will build the left half of the cellulose sheet shown below. That will require 16 beta-D-glucopyranose molecules, but some oxygens and hydrogens will need to be replaced with 3-hole trigonal oxygens in order to accept the hydrogen bond connections. Since we do not have 3-hole trigonal oxygens, we will fake it with 4 hole oxygens.



The screen shot below shows “ball and stick” model of the upper half of the cellulose sheet shown above. It is made from 96 carbons, 164 hydrogens, and 82 oxygens. It is strengthened by 24 hydrogen bonds requiring 2-hole hydrogens and 4-hole oxygens. The 140 other hydrogens and 58 oxygens are the normal style. 192 rigid bonds are also needed.