

Instructions for Building Starch and Cellulose with Paper Atoms

An additional activity with glucose molecules

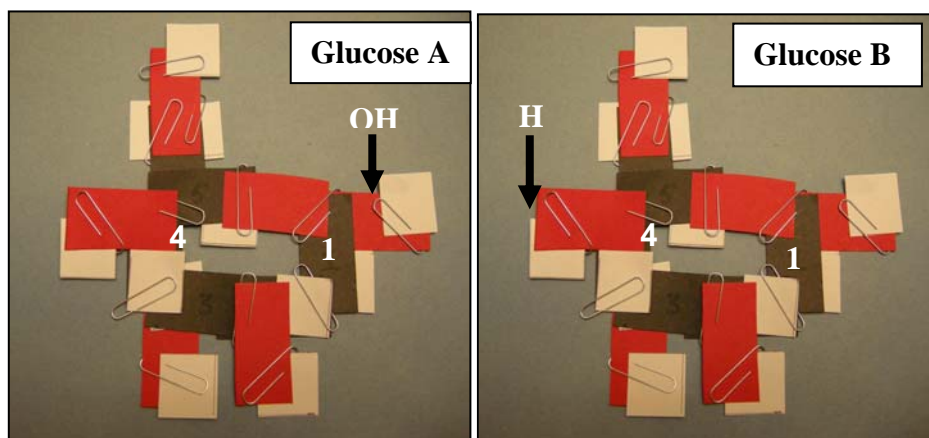
Designed by Kathleen M. Vandiver (Copyright MIT © 2009)

General instructions for the class

- Each group will prepare two glucose molecules from each student kit. Use the instructions for making glucose molecules.
- Some student groups will build starch molecules and other students will build cellulose molecules.
- Groups building the starch molecules may be asked to connect their short chains together to make a much longer molecule.
- If you are finished building before others, please figure out the molecular formulas for the larger starch molecules you might make. (For example, the simple 2 sugar molecule is $C_{12}H_{22}O_{11}$. What would the formula be for a starch molecule with 8 sugars or 12 sugars?)

Starch molecule instructions

Build 2 glucose molecules from your kit. A water molecule will be removed between the 2 glucose molecules. Line up the two glucose molecules together like this. Then follow the steps below. More glucose molecules are added on in the same way to create a very long chain of starch.



Step 1.
Remove the OH group from carbon 1 in Glucose A.

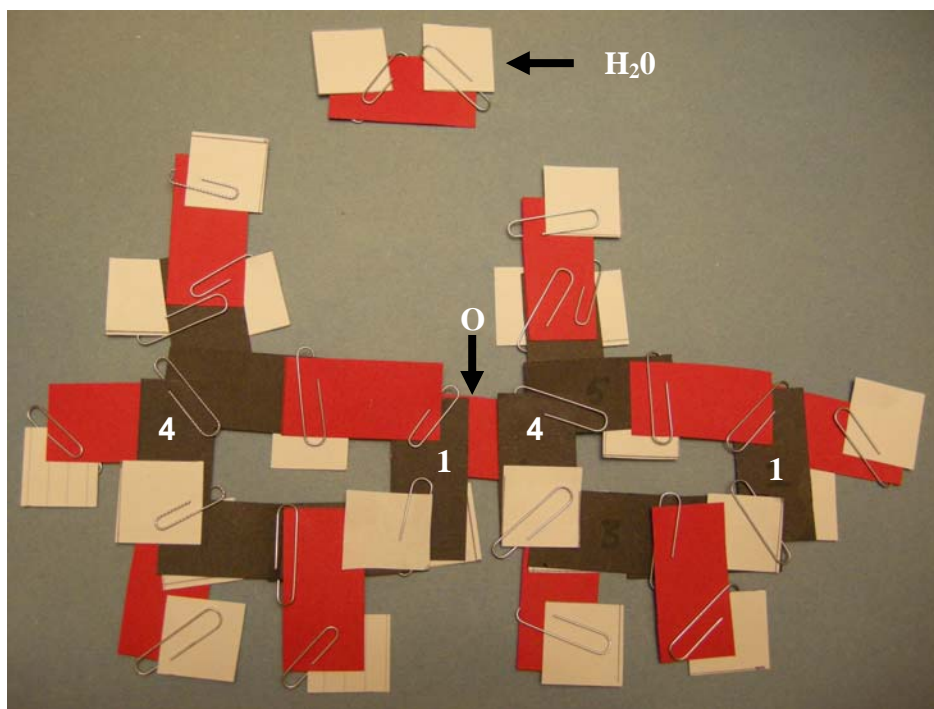
Step 2.
Remove the H atom from carbon 4 in Glucose B.

Step 3.
Form a water molecule with the H and OH group. It is marked with an arrow.

Step 4.
Join the two rings of glucose with the oxygen marked with the arrow. The oxygen joins Glucose A with Glucose B.

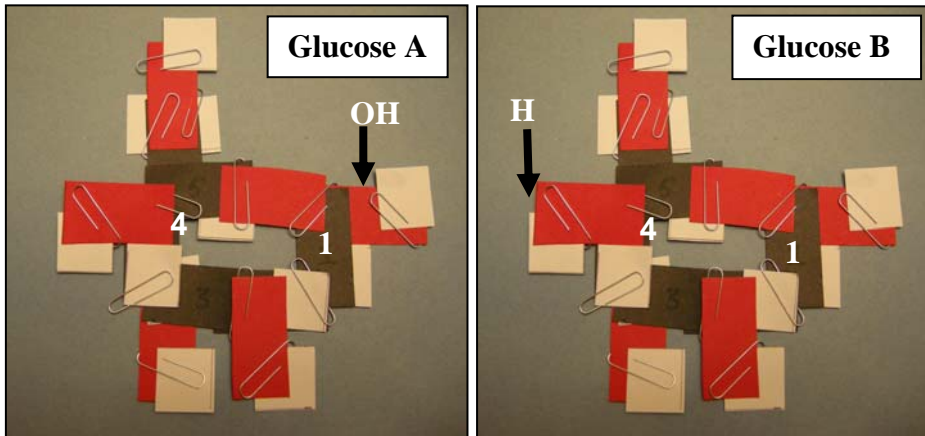
The oxygen should link carbon 1 and carbon 4 of the two glucose atoms. This is now a molecule of starch!

Ask your teacher if you should continue to build a longer starch molecule with other groups. Remember to remove the water molecule.



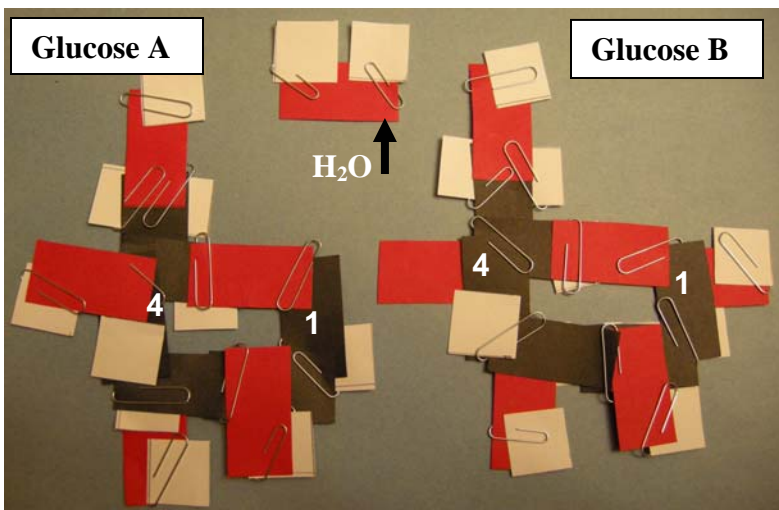
Cellulose molecule Instructions

Build 2 glucose molecules from your kit. A water molecule will be removed between the 2 glucose molecules. Line up the two glucose molecules together like this first.

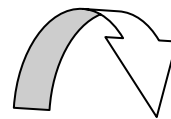


Step 1.
Remove the OH group from carbon 1 in Glucose A.

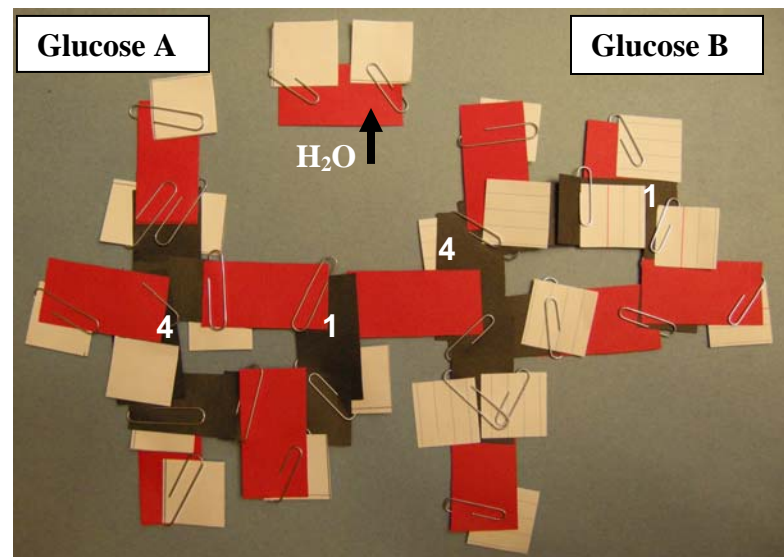
Step 2.
Remove the H atom from carbon 4 in Glucose B.



Step 3.
Form a water molecule with the H and OH group.



Step 4. Pick up glucose B and place it face down. The motion is indicated by the large arrow. Below see the up-side down glucose B.



Step 5. Join the two glucoses with the oxygen.

Summary In cellulose every glucose is joined to the next one, alternating up-side down and right-side up, as explained in the video. The glucose rings are bonded to each other through an oxygen atom. The oxygen links carbon 1 and carbon 4. This is the same linkage as starch. (See page 1.)

Animals have enzymes that can break starch apart into individual sugars, but animals can not break cellulose apart into sugars.

Cellulose molecules are very long. This is a short example. If other groups in the class have built a short cellulose, you may connect them. Ask your teacher. Remember to remove a water molecule between each glucose, and use a 1 to 4 linkage. Congratulations on building a cellulose model!