Name: Date:

HANDS-ON ACTIVITY

Modeling Biochemical Compounds

Atoms bond together to make molecules. Many molecules can also bond together to form bigger molecules. Molecules that make up living organisms are often large and complex. For example, many biologically important carbon-based molecules are polymers, which are composed of many simple subunits called monomers. Starch is composed of many simple sugar units bonded together. Proteins are made of many amino acids bonded together. Nucleic acids, such as DNA, are made of long strands of subunits called nucleotides.

Scientists often use models to help study and understand atoms and molecules. Biochemists use computers to make molecular models in which all the atoms and atomic bonds of a molecule are included. In this lab, you will use ordinary materials to model atoms, small molecules, and polymers.

PREDICT

How do atoms, molecules, and polymers compare?

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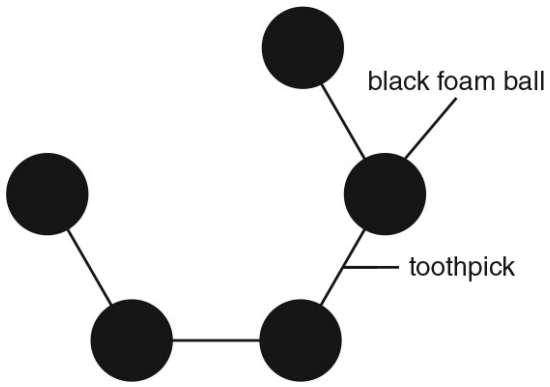
MATERIALS

- ball, black foam (9)
- ball, red foam (3)
- bead, large red (1)
- bead, small blue (2)
- colored pencils
- construction paper
- cotton batting
- protractor
- scissors
- tape, clear, 50 cm
- tape, double-sided, 6 cm
- toothpicks (25)

PROCEDURE

Part 1: Modeling atoms and molecules

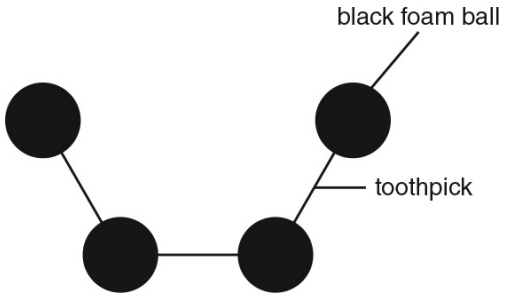
1. Construct a simple model of an oxygen atom. The red bead represents the nucleus. Wrap the bead with a small piece of double-sided tape. Wrap cotton around the bead so that cotton completely surrounds it. The cotton, which represents the electron cloud surrounding the nucleus, should be loose and wispy.
2. Make two models of hydrogen atoms. Follow Step 1, but use a blue bead to represent the nucleus of a hydrogen atom.
3. Make a model of a molecule of water. Connect the two model hydrogen atoms to the model oxygen atom by securing the cotton together.
4. Make a model of a glucose molecule's ring structure. Glucose is composed of a ring of 5 carbon atoms and an oxygen atom. Obtain 5 black foam balls. These will represent carbon atoms. Use toothpicks to “bond” the atoms together at ~120° angles. For simplicity, additional oxygen and hydrogen atoms bonded to the ring will not be included in the model.



5. Use toothpicks to attach a red foam ball (oxygen) to complete the ring structure of glucose. Glucose is a simple sugar, or monosaccharide.

6. Build a model of another simple sugar, fructose. Fructose contains a ring of 4 carbon atoms and an oxygen atom bonded together. As with the model of glucose, additional hydrogen and oxygen atoms bonded to the ring will not be included in your model. Connect 4 black foam balls together with toothpicks at ~108° angles. Complete the ring with toothpicks and a red foam ball.

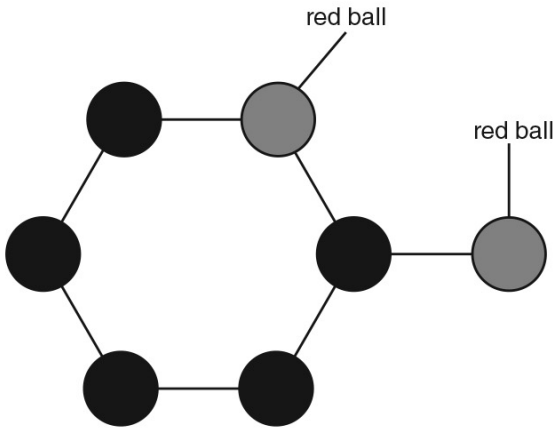
   Attach the black balls (carbon atoms) together at 108° angles.



7. Make a model of sucrose (a disaccharide) by bonding the glucose to the fructose.

   Connect one of the carbon atoms that is next to the oxygen atom in your glucose model to another oxygen atom, as shown.

   Connect a red ball (oxygen) to the glucose model.



8. Insert a toothpick into the new oxygen atom. Use it to connect the oxygen to a carbon that is next to the oxygen in the fructose model.

Part 2: Modeling polymers

9. Connect several glucose molecules together to model the polysaccharide called starch. Make glucose models out of paper by drawing several hexagons on construction paper. Use the scissors to carefully cut the hexagons out of the paper.

10. Tape a toothpick to one corner of each hexagon, so that most of it extends beyond the paper.

11. Tape the toothpick from one glucose hexagon to the end of another glucose hexagon. Be sure that you attach the toothpick to the end that is opposite to that hexagon's toothpick. Keep connecting the hexagons until they are all linked together to form a model of a part of a starch molecule.

12. Make a model of an amino acid chain to represent part of a protein molecule. Draw several circles on a piece of construction paper and use the scissors to cut them out. Each circle of construction paper represents an individual amino acid.

13. Use the colored pencils to identify different amino acids. Because there are 20 different amino acids that make up most proteins, use different colors so that you have several different amino acids.

14. Make an amino acid chain similar to the way in which you constructed your model of starch.

ANALYZE

1. In your oxygen atom model, where would protons be found, in the bead or in the cotton cloud? What about neutrons and electrons?

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2. How are glucose and fructose similar? How are they different?

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3. How are starch and sucrose similar? How are they different?

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4. What are some similarities between your protein and polysaccharide (starch) models?

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5. Describe the strengths and weaknesses of using these models to represent atoms and molecules.

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EXTEND

If you have a molecular modeling kit, make a molecular model of glucose. This model will include a ring with five carbon atoms and one oxygen atom and all the additional atoms bonded to the carbon atoms in the ring.