

Tasty Models



Pillar: Healthy Eating

Division IV

Core Curriculum Connections: Science (Chemistry 20)

I. Rationale: Understanding the arrangement of atoms within nutrient molecules often helps explain their chemical behaviour, health attributes and role in weight balance. Although atomic representations do not accurately represent electron configurations, they can be used to show the arrangement of nuclei and bond type. In the following activities, students will construct several different molecular models that represent substances that play an essential role in our nutritional needs.

II. Activity Objectives:

This activity will offer:

- insight into atomic arrangement of several nutrients.
- a hands-on experience in constructing models.
- a visualization of dehydration synthesis using molecular models.
- a visualization of bond saturation in fat molecules.
- an opportunity to apply critical thinking to atomic modeling.

III. Core Curriculum Outcomes: Chemistry 20

Unit A: The Diversity of Matter and Chemical Bonding

General Outcome:

Describe the role of modelling, evidence and theory in explaining and understanding the structure, chemical bonding and properties of molecular substances

20–A2.2k explain why formulas for molecular substances refer to the number of atoms of each constituent element

20–A2.6k illustrate, by drawing or by building models, the structure of simple molecular substances

20–A2.2s build models depicting the structure of simple covalent molecules, including selected organic compounds

IV. Materials

- gum drops (variety of colors)*
- toothpicks
- or ball and stick models

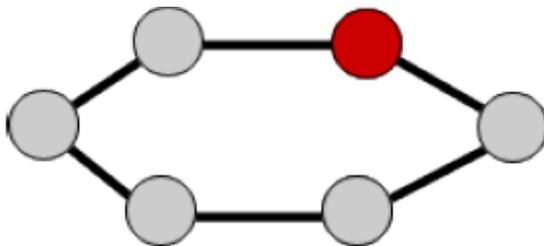
V. Procedure

Activity 1: Carbohydrates

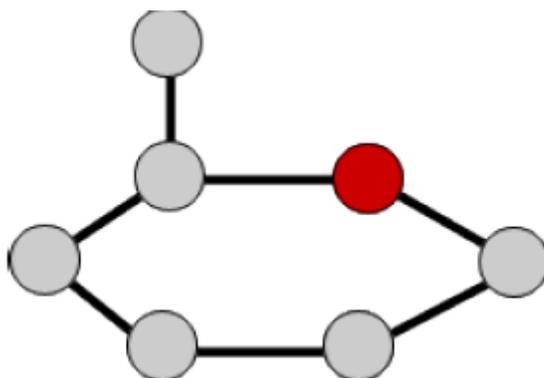
Carbohydrates are a group of nutrients that include sugars and starches. Perhaps, the most familiar carbohydrate building block is glucose. Glucose is a monosaccharide, which means that it contains one sugar unit. Monosaccharides can be joined together to produce larger chains of carbohydrates. Starch is an example of a long chain of sugar molecules that are linked together. In this set of activities, you'll construct a single sugar (glucose) and observe the effects of a dehydration synthesis reaction.

A. Glucose Model

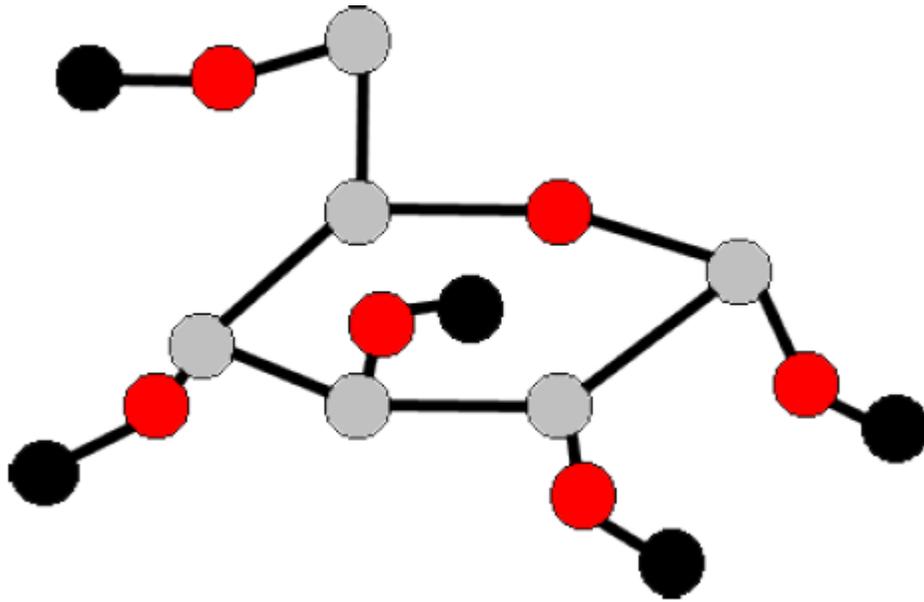
1. Examine the study of gumdrops that you will be using to assemble your molecular models. Now, consider the formula of glucose, $C_6H_{12}O_6$. Based on this formula, how should you assign specific colors to the component atoms? (The most common color should be assigned to hydrogen, since hydrogen atoms are the most numerous.)
2. To build the ring version of glucose, let's construct a closed ring formed by five carbon atoms and one oxygen atom.



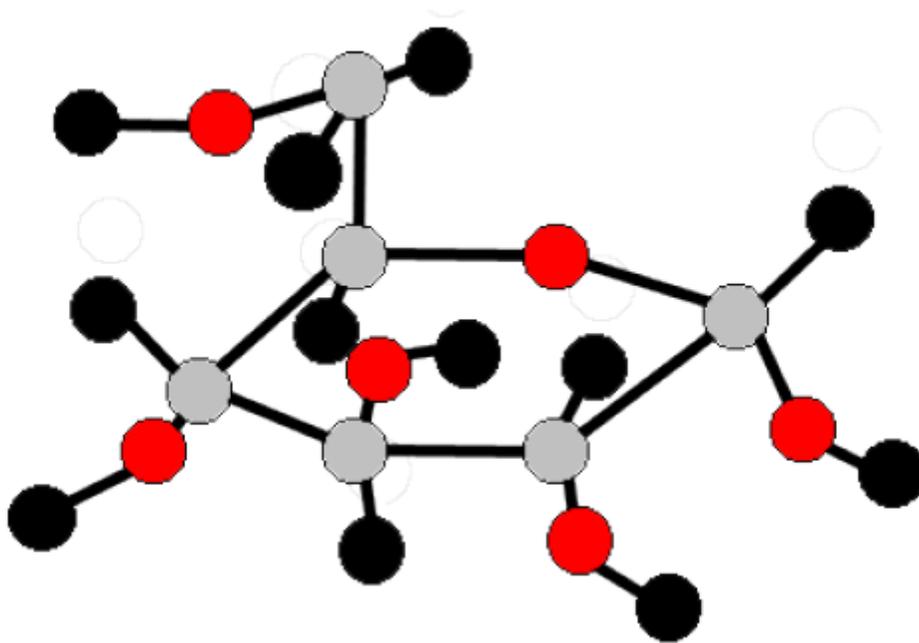
3. Now, let's add the sixth carbon atom. It is attached to the ring carbon that is immediately to the left of the oxygen atom.



4. The remaining five oxygen atoms are part of hydroxyl (OH) groups. They are added as shown here.



5. Finish the model by adding the remaining seven hydrogen atoms so that each carbon atom forms four bonds.

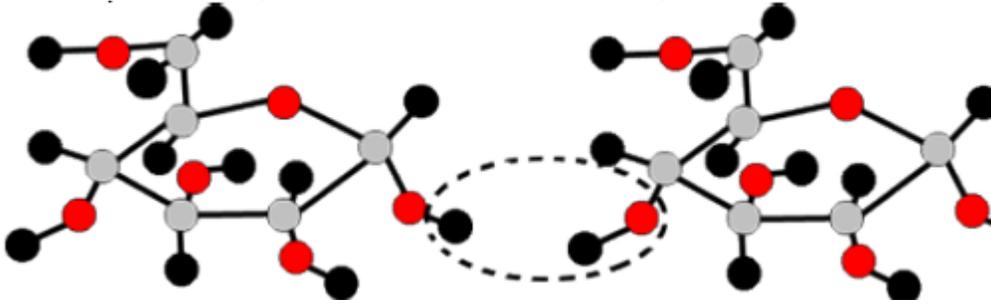


B. Modeling Dehydration Synthesis

To produce larger carbohydrate molecules, glucose is linked to other sugar molecules. During this bonding process, two atoms of hydrogen and one atom of oxygen are removed from the linking sugars. These atoms join together to produce a molecule of water. Hence, this type of sugar bonding is called dehydration synthesis.

1. Construct a second model of the glucose model.

2. Place both models side-by-side. Remove the two hydrogen atoms and one oxygen atom that are associated with dehydration synthesis (identified by the dashed line).



3. Join the free bond of the ring oxygen atom to the free bond of the carbon atom. Join the three removed atoms together to form a molecule of water.

Questions

1. What type of molecule is removed during dehydration synthesis?
2. What happens to the "open" bonds that are created as neighboring sugar molecules lose component atoms?
3. What might happen if you added water to a starch molecule?

Activity 2: Proteins

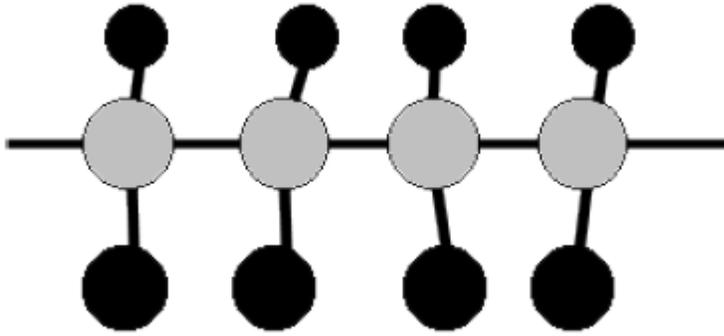
Proteins are macromolecules that are found in every living cell. Like carbohydrates, they form a critical part of our diet. They are also the profiled nutrient in the Atkins diet. The basic building block of a protein molecule is an amino acid. All amino acids share a common feature; they contain both an amine (NH₂) group and a carboxyl (COOH) group.

Glycine Model:

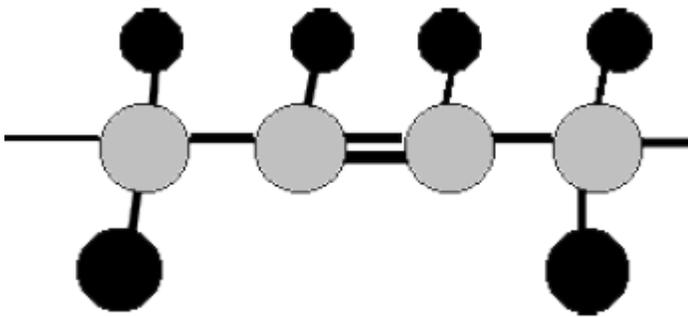
1. Glycine is the simplest structural amino acid. Like all amino acids, it has an amine (NH₂) group. Use gumdrops to construct this functional group.



2. Like all amino acids, glycine also has a carboxyl (COOH) group. Use gumdrops to construct this functional group. Remember to retain consistency in your assignment of gumdrop colors.



3. The amine and acid group are both attached to a central carbon atom. The remaining two bonds of this backbone carbon are saturated with hydrogen. Your finished glycine model should resemble this image.



Questions

1. What are common features to all amino acids?
2. Compare and contrast the composition of an amino acid to a sugar.
3. From what you can observe in the molecular structure, can dehydration synthesis also produce long chains of amino acids? Explain.

Activity 3: Saturated and Unsaturated Fats

Although you may not know what they are, chances are you've heard of saturated and unsaturated fats. Fats are long molecules that can have more than 20 carbon atoms in their backbone. A saturated fat has only single bonds in its carbon backbone. An unsaturated fat has one or more double bonds.

1. Construct a chain of four carbon atoms.
2. Add two hydrogen atoms to each carbon atom. Place a toothpick at both ends of the chain to represent the bond that connects this section to the rest of the fat molecule.
3. Now construct a version of this carbon backbone that contains an unsaturated carbon.

Questions

1. When saturated, to how many different atoms can a carbon bond?
2. What must be added to an unsaturated chain, in order to make it saturated?
3. Infer the structural feature of a "polyunsaturated fat."

V. Extensions:

Computer Modeling:

There are all sorts of computer molecular modeling programs on the web. Many are free to use and offer powerful construction and manipulation tools. Check out some of these free tools at <http://ep.llnl.gov/msds/dvc/viewers.html>. For MACs running under OS X, iMOL is a powerful program that you can download it at <http://www.pirx.com/iMol>.

3D Models From a 2D Image

By "freeviewing" two side-by-side images, you can experience the stereoscopic illusion of depth. This technique is sometimes used by scientists to help illustrate three dimensional layout of molecules. Check out this URL for some screen-popping

<file:///D:/My%20Documents/PINKY's%20FILES/Web%20Files/1401/teaching/teachinghspdf.htm> examples of the freeviewing effect: <http://valhalla.chem.udel.edu/3-D.html>.

Custom Model Building

Use the Internet and print resources to identify additional types of molecules that play a role in nutrition. Then, using either computer-assisted drawing programs or common materials, construct models of these atomic arrangements. From their composition and structure, make inferences about their role in nutrition.

Web Connection

Specialized Diets

A reference to the biochemistry of various nutrients and diets.

<http://reference.allrefer.com/encyclopedia/N/nutritio-human-nutrition-specialized-diets.html>

Glucose Model

A comprehensive overview of constructing a variety of glucose molecules including straight chain and isomer examples.

<http://www.mansfield.ohio-state.edu/~sabedon/biol4020.htm>

Origin of the Atom

An overview of fats in the diet presented by the University of Michigan

http://www.umich.edu/~chemstu/studios/chemical%20bonding/CBSEA/cbsea_q3_reading.htm

Answer Key:
Tasty Models

Modeling Dehydration Synthesis Questions

1. What type of molecule is removed during dehydration synthesis? **(Water)**
2. What happens to the "open" bonds that are created as neighboring sugar molecules lose component atoms? **(The "open" bonds from neighboring sugars join together and link the side-by-side sugars into a disaccharide)**
3. What might happen if you added water to a starch molecule? **(Water would cause neighboring sugars to unlink in a reverse reaction to dehydration synthesis)**

Glycine Model Questions

1. What are common features to all amino acids?
(An amine (NH₂) group and a carboxyl (COOH) group)
2. Compare and contrast the composition of an amino acid to a sugar.
(Both include carbon, hydrogen, and oxygen atoms. Amino acids also contain atoms of nitrogen)
3. From what you can observe in the molecular structure, can dehydration synthesis also produce long chains of amino acids? Explain. **(Yes. This might occur when neighboring molecules align so that the H from one amino acid joins to the OH group of the other. Water is released and the "open" bonds close and connect the side-by-side amino acids.)**

Saturated and Unsaturated Fats Questions

1. When saturated, to how many different atoms can a carbon bond?
(Four)
2. What must be added to an unsaturated chain, in order to make it saturated?
(Hydrogen)
3. Infer the structural feature of a "polyunsaturated fat."
(The fat molecule has more than one double bond in its structure)

