

Have Your DNA and Eat it Too

Abstract

Students build an edible model of DNA while learning basic DNA structure and the rules of base pairing.

Learning Objectives

- Students will be able to describe the structure of the DNA molecule.
- Students will be able to explain the rules of base pairing.
- Students will understand that information is stored within the DNA molecule in the form of a sequence of chemical bases, each referred to by the first letter of its name (A, T, C and G).

Estimated time

- Class time 45 minutes
- Prep time 60 minutes

Materials

- Student handouts

Per student or group

- 2 licorice sticks (e.g., Twizzlers)
- colored marshmallows (9 each of green, pink, yellow, and orange)
(slightly dry ones work a little better)
- 12 toothpicks
- 5 paperclips
- Masking tape

Background

DNA provides the instructions for building and operating all living things. The DNA instructions are divided into segments called genes. Each gene provides the information for making a protein, which carries out a specific function in the cell.

A molecule of DNA (DeoxyriboNucleic Acid) is composed of two backbones and four types of chemical bases. The backbone is formed by a chain of alternating phosphates and sugars. Each sugar molecule in the backbone provides an attachment site for one of the chemical bases. The four types of chemical bases are: adenine, thymine, cytosine and guanine. They usually are represented by their first letters: A, T, C and G. The bases form pairs in a very specific way: A always pairs with T, and C always pairs with G. A pair of bases is connected by hydrogen bonds. Each base in the pair is also connected to a sugar compound in the DNA backbone.

A DNA molecule is often compared to a ladder, with the two backbones forming the sides of the ladder and the base pairs forming the steps, or rungs. However, instead of a straight ladder, DNA looks like a twisted ladder, known as a double helix (“double” for the two backbones). The DNA sequence is the consecutive order of bases on one side, or strand, of the twisted ladder. The other strand has a complementary sequence determined by the base pairing rules.

The specific matching of the base pairs, A with T and C with G, provides a way for exact copies of DNA to be made. This process is called DNA replication. In DNA replication, the double helix ladder is untwisted and the two strands are separated by breaking the hydrogen bonds between the base pairs. Next, two new strands are made by reading each side of the DNA ladder, one step (base) at a time. At each step, the matching base fills in (with its associated sugar and phosphate) to complete the rung and lengthen the new DNA strand. When the process is complete, there are two identical DNA double helices, each containing one original and one new strand.

DNA replication is an important part of the cell division process. Before a cell divides, it first duplicates its DNA so that the new cell will have the same genetic information. The specific base pair matching during replication ensures that exact DNA copies are made.

Instructions

1. Begin class with a discussion about DNA. Include in your discussion that DNA contains all of the instructions necessary to build and operate a living organism and that DNA molecules can be found inside the cells of all living things.
2. Show students a diagram depicting what the DNA molecule looks like as you describe its structural features. Inform students about the four-letter DNA alphabet, A, T, C, and G, and describe the rules of base pairing. Explain that information is stored within the DNA molecule in the form of a sequence of chemical bases represented by these four letters. You may want to use the information and animations in [What is DNA?](#)
3. Invite students to work alone or with a partner to follow the instructions in the student handout and build their very own edible model of the DNA molecule.
4. When students have completed the activity, assess their understanding of the structure of DNA by examining whether or not they have built and labeled their models correctly and followed the rules of base pairing.
5. Reinforce that the structure of DNA and the rules of base pairing enable the molecule to perform its function of storing heritable information.

Extensions

- Follow this activity with the [Reading DNA](#) activity in which students use their edible DNA models to transcribe a short gene, then translate it into a protein.
- Either before or after this activity have students extract and visualize DNA from Mendel’s favorite organism, the pea, by following the instructions in [How to Extract DNA From Anything Living](#).
- Have students research when and how the structure of the DNA molecule was discovered and

by whom.

- Have students simulate DNA replication using their models. Break the toothpicks in the center to separate the two strands. Use another stick of licorice, more marshmallows, and toothpick halves to form the new DNA strand.

Misconceptions

- Although students may understand that living systems are made of cells, they may not understand that living things are also made of molecules. (Students often associate molecules only with physical science.) Emphasize that DNA is found inside the cells of all living things, and that the structure of the DNA molecule is the same in all living things.
- Because the structure of the DNA molecule is the same in all living things, students may not understand that the diversity of life is the result of differences within the DNA sequence.



Have Your DNA and Eat it Too!

When isolated from a cell and stretched out, DNA looks like a twisted ladder. This shape is called a double helix. The sides of the DNA ladder are called the backbone and the steps (also called rungs) of the ladder are pairs of small chemicals called bases. There are four types of chemical bases in DNA: Adenine (A), Cytosine (C), Guanine (G), and Thymine (T). They form pairs in very specific ways: Adenine (A) always pairs with Thymine (T) and Cytosine (C) always pairs with Guanine (G).

Your task is to use the following materials and procedure to construct an edible model of DNA. When you are finished, use toothpicks and tape to label one of each of the chemical bases.

You will need:

- 2 pieces of licorice
- 12 toothpicks
- 9 pink marshmallows
- 9 yellow marshmallows
- 9 green marshmallows
- 9 orange marshmallows
- 5 paperclips
- Masking Tape



1. Choose one of the sequences below.

Sequence 1: T A C G T A T G A A C

-or-

Sequence 2: T G G T T T A G A A T T

Adenine (A) = Green



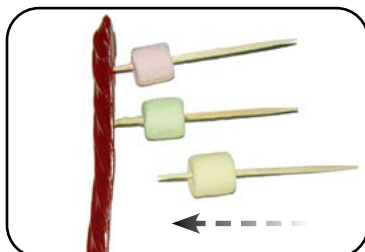
Thymine (T) = Pink



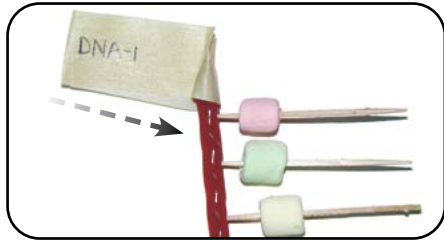
Cytosine (C) = Yellow



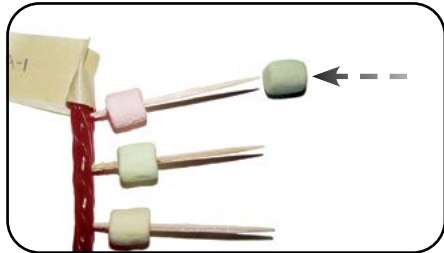
Guanine (G) = Orange



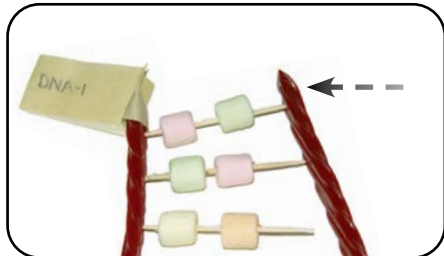
2. Assemble one side of your DNA molecule. A piece of licorice will form the backbone and marshmallows will be the chemical bases. Place a marshmallow on the end of a toothpick so that the point of the toothpick goes all the way through. Anchor the toothpick into the licorice backbone. Refer to the table above to choose the correct color marshmallow to represent the chemical bases in your sequence.



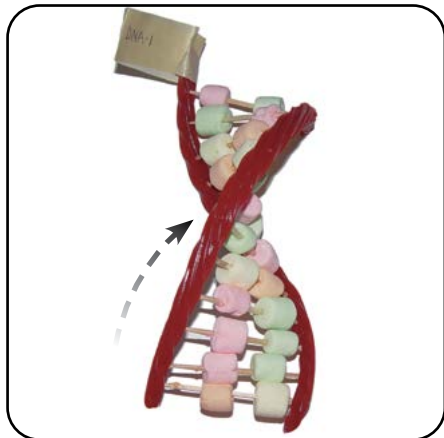
3. Label the backbone. With a marker or pen and masking tape, label your licorice backbone "DNA-1" or "DNA-2" depending on which sequence you used. Write the label on the left end of the licorice.



4. Match the chemical base pairs. Place the color marshmallow for the matching chemical base on the other end of each toothpick. Remember that A always pairs with T and C always pairs with G!



5. Complete your DNA model. Attach the other backbone so your model looks like a ladder.



6. Twist your DNA model. Carefully twist your DNA molecule so that it looks like a double helix.



7. Label your model. Make flags to label the parts of your DNA out of paper clips and tape. Label one of each of the following: Adenine, Thymine, Cytosine, Guanine, and Backbone. Make sure your chemical base pairs are correct!