HS Lesson 3: The Structure of DNA

(Pre-Exhibit Visit)

Objective:

Students will describe the structure of the double helix, explain how DNA copies itself, recognize that the sequence of DNA is what makes each individual unique, and recognize that similarities in the sequence of DNA indicate relationships and similarities between species.

Curriculum Connection:

This lesson should be taught at the beginning of a unit on DNA. It requires only basic knowledge that DNA is the hereditary material. Building on this knowledge, students will construct a model of DNA and model the process of replication.

Exhibit Link:

This lesson directly relates to *What is DNA?* in the exhibit, which explains the connection between DNA and genes and allows students to twist the double helix structure and connect new bases to create two new copies of DNA. It also connects with *How Similar Are You? and Zip/Unzip!*, which talk about similarities between DNA sequences in humans and various species.

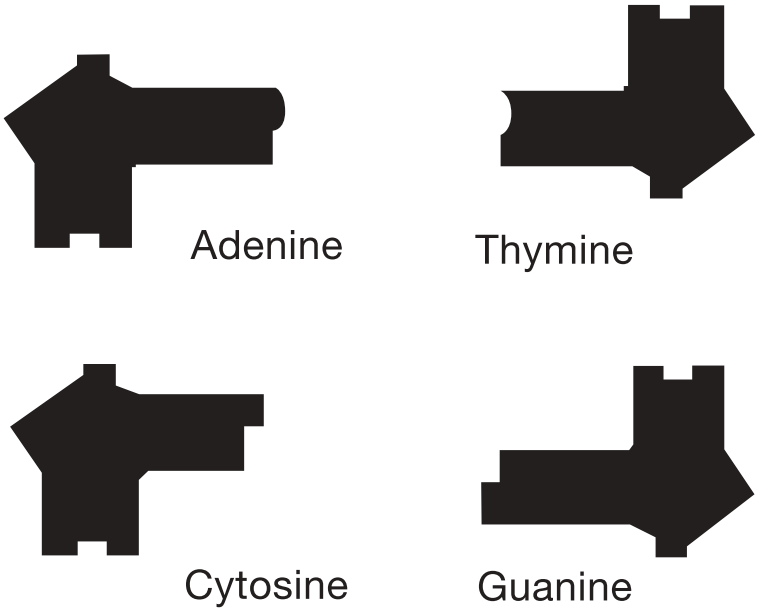
Class Time Required:

90 minutes

Materials Needed:

For each student:

- Crayons or markers
- Scissors
- Tape
- Paper
- Two copies of nucleotide pairs shown here



Focus Activity:

Divide students into pairs. Write the following sentences on the board:

1. Each cell's DNA would be six feet long if spread out.
2. Your DNA is 99.9% the same as the person sitting next to you.
3. Your DNA is 90% the same as a mouse.
4. Your DNA is 60% the same as a fruit fly.

Have students decide and provide reason why each of the statements is true or false. (All are true.)

Lesson Steps:

1. Tell students all statements are true. Ask what it is about DNA that makes them 99.9% similar to other humans. Have students contribute their own ideas, then lead them to the idea that the structure and sequence of DNA makes you unique. The more similar the DNA, the more closely related the species (or individual in a species) are evolutionarily.

2. Once you have established that the structure of DNA makes us both unique and similar to others, give students basic information about the structure. DNA is made up of nucleotides. Each nucleotide has three parts: five-carbon sugar (deoxyribose), phosphate, and a nitrogen base. There are four nitrogenous bases: adenine, thymine, cytosine, and guanine. These nucleotides join together to form two strands, with the nitrogenous bases connecting in the middle of the two strands. Adenine binds to thymine, cytosine to guanine. The two strands twist around each other to form what is known as a double helix. Show students a picture of a double helix.
3. Distribute the paper nucleotide replicas, crayons/markers, scissors, and tape to students. Students should still be in pairs; however each person will color, cut out, and construct his or her own model. Instruct them to color each part of the nucleotide a specific color. That is, color all phosphates one color, all deoxyriboses another color, all adenines another, etc. Then, instruct students to cut out each nucleotide and piece them together like a DNA molecule. One partner should tape his or her strands together but not tape them in the middle. (Students should be able to open and close the DNA strand that they build.) The other partner's model should be put together, but not taped anywhere. Let them know that they may have to be creative to get the helix to fit together (e.g., they may need to flip over some of the bases to get the other strand).

4. When finished, tell students you will use their structures to model the way DNA copies itself through replication. Have students take the model with the taped sides and separate the two strands. (This is the first step of replication, where the DNA molecule unzips.) Then they should use their partner's untaped nucleotides, bringing in each nucleotide and binding it to the appropriate base. (This is the second step of replication where free floating nucleotides come and bind to each of the old strands.) Finally, ask students to check their two new DNA strands to ensure they did not make any mistakes. (This is the third step of replication, where an enzyme checks for errors.)
5. When finished, have all students tape their models to a white piece of paper to display them. Talk about how to make strand with template and how each strand is part "old" and part "new" and think about why that might be a good way to copy and proofread.

Extensions & Modifications:

- Use all the DNA molecules built by the class to construct a giant molecule of DNA to display in your classroom.
- For lower level students, skip Step 4 and simply have students tape their models to a piece of paper for display.
- For more advanced students, do not write in adenine, thymine, cytosine, and guanine. Allow them to fill in the appropriate nitrogen bases in order to construct the model.

Important terms: DNA, nucleotide, nitrogen base, replication, adenine, thymine, cytosine, guanine

Writing Prompts/Potential Discussion Questions:

1. Your DNA is 98.4% similar to a chimpanzee and 50% similar to a banana. How can your genome be so similar to theirs? What do your cells have in common with banana cells? What is the same about the DNA? What does this suggest about your relationship to other species?
2. Every cell in your body, except your red blood cells contains a copy of your DNA. When you were first conceived, you were made of only one cell. Explain how important the steps of replication are in the growth and maintenance of your body.
3. Discuss why specific base pairing is essential in the process of replication.
4. Discuss the importance of the final step of replication where the enzyme checks for mistakes.

Additional Resources:

DNA Workshop – DNA Replication
http://www.pbs.org/wgbh/aso/tryit/dna/replication.html
This website sponsored through PBS, gives excellent basic information about DNA structure and replication.

DNA Replication
http://www.eurekascience.com/ICanDoThat/dna_rep.htm
This website is designed for younger kids, and gives an excellent simple explanation for the process modeled in this lesson.

National Standards Addressed:

Standard C – The Molecular Basis of Heredity

In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular "letters") and replicated (by a templating mechanism).