Lab Safety

Clean work area thoroughly after lab completion Return all materials to appropriate location as directed

Overview

In this ninety minute lesson (two class periods of 45 minutes) students will be given the opportunity to explore the structure of the DNA molecule. Students will construct a DNA model, describe the structure and function of DNA, sequence the steps involved in DNA replication, and plan and design a model of DNA. This lesson should be done after a lesson on the structure and function of cells.

Learning Outcomes

Student will be able to:

- construct DNA molecules using the 4 nitrogenous bases (ATCG).
- write about the structure and function of DNA.
- discuss and sequence the steps involved in DNA replication.
- plan and design a model of DNA.

Prerequisite Knowledge & Skills

Knowledge

Students should be able to:

- discuss the structure and function of cells and where DNA is located in the cell.
- describe the relationship between the chromosome and DNA.

Skills

Students should be able to:

- conduct careful observation.
- record, analyze, and report data from observation.

Misconceptions

Possible student misconceptions include: DNA is a living thing, different cells within an organism have different DNA, and that only animal cells have DNA.

Materials and Equipment

- Student lab note book
- Molecular model kit
- Large 3-D model of DNA

Per student:

- $2 \frac{3}{4}$ " x 13" black and white striped foam strips
- 18 1/4" wooden dowels cut into:
 - o 1" pieces, painted orange and green
 - o 2" pieces, painted yellow and blue
- 18 upholstery tacks
- 9 1/4" x 1" clear vinyl tubing pieces
- Corresponding printable student worksheets

Lesson

Day 1 Pre-lab (45 minutes) Teacher Prep

- Photocopy the "Background Reading" from the Student Lab Notebook on the Lab Center website.
- Review the history of the DNA molecule on the DNA Interactive Internet site at: www.dnai.org < Code
- Read the background information and the teaching tips in the Teacher's Guide

a) Before Class:

Students will receive "Background Reading" for the lab activity to read for homework the night before starting the lab and will write 2-3 questions they have about the background information. Students will also highlight any unfamiliar terms and write the meaning of one of the terms that they have highlighted according to the context in which the word is used in the "Background Reading."

b) During Class:

Pair –Square (2 pairs) - Using the questions they developed from the homework assignment, each group comes to consensus on one question that they find most interesting. Each group records this question on a sentence strip to be collected by the teacher and posted in the classroom. The teacher will also post one or two of his/her own questions.

c) Mini-lesson:

Explain to students that DNA is called the molecule of life but it is not a living thing. DNA is a molecule, just like glucose or water, but it is a molecule with special instructions for a cell. The DNA in a cell can be compared to a recipe book, and the genes to individual recipes for traits and characteristics. Without the machinery of the cell, the DNA cannot function.

Ask the class where in the cell DNA is located. Have students examine the picture of a DNA model at this website http://www.agriscience.msu.edu/specialprojects/biotechnology/biotechpart4/dna.gif and record what they have observed in their lab note book.

Ask for volunteers to share what they have observed with the class. During this class discussion focus on the structure of DNA (what it is made up of), specifically the 4 nitrogenous bases, and the complementary base pairs.

As a culminating activity for this lab have students create a post card featuring the structure and function of DNA to send to a friend. Students can include a small drawing that shows the structure of DNA.

Day 2

Lab Activity (45 minutes) Teacher Prep

Photocopy the "DNA Structure" and "DNA Replication" worksheets from the **Student Lab Notebook**.

Part 1

- Introduce the students to the materials that they will be working with in this lab activity.
- Explain how organisms can grow from a single cell through the process of cell division and that DNA replicates within cells when they divide.
- Instruct the class to examine a 3-D model of DNA. Discuss the shape of model and why it is called a double helix. Use the interative clip for the Lab Center titled: **The DNA Double Helix**, to hear James Watson describe the discovery of the double helix. Point out that the model has 6 different colors on it, and that each color represents a small molecule that is one part of the whole molecule. Have students write the 6 different colors on the 3-D model of the DNA in their lab note books and what they represent.
- Using the "DNA Structure" handout, have students examine the chemical components of the DNA molecule. Instruct the students to start their examination with the backbone, which is made of repeating molecules of deoxyribose sugar and phosphate groups.
- Ask the students why this part of the molecule is called the backbone. They might notice that deoxyribose sounds familiar because the acronym DNA is short for Deoxyribonucleic Acid. Many times molecules are named for their chemical components and characteristics. Ask students why the molecule is called a nucleic acid (teacher, read the background info for the answer.)

Part 2

- Instruct students to focus next on the base pairs, which comprise the rungs of the DNA ladder and to read the chemical names.
- Explain to the class that many times they are called A, T, G and C for short. Point out that they have partners. Call on different students or ask for a volunteer to write each base and it's partner on the chalkboard
- A is bound to T, and G is bound to C. An easy way to remember the base pairing is the pneumonic:
 At The

Grand Canyon, they fell in love.

If time allows, give students the opportunity to play with the **DNA Base-Pairing Interactive** on the Lab Center to re-enact Watson and Crick's method.

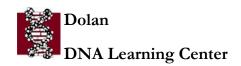
- Using an alphabet analogy, illustrate to students how a simple four-letter code can carry information for all living organisms. For example, using the three letters C, A, and T, how many words can you make?
- Explain further to the class that the alphabet has 26 letters, and by simply rearranging the order of letters, or adding/taking letters away, we can make new words.
- Genes are specific ATGC sequences that carry information to make proteins. The DNA in a cell is the "cookbook" and genes are the individual "recipes".
- Instruct students to examine the "DNA Replication" handout. Explain to the students that when DNA replicates it makes an identical copy of the original DNA strand.
- Have the students read how DNA replicates from the "DNA Replication" handout, and discuss the steps that are involved in the replication of DNA.
- Instruct the students to sequence these steps in their Lab Notebooks. Show the 3-D animation of DNA replication from DNA Interactive: http://www.dnai.org/a/index.html.
- Demonstrate how to construct a DNA model using the materials supplied. The black and white striped foam pieces represent the backbones and the wooden dowels represent the four bases. Each base pair is held together by a piece of vinyl tubing, and the pairs are held to the white squares on the backbone with upholstery tacks. Each student should try to create a unique pattern of bases, just like the unique patterns we see in our own genes.

Day 3

Post Lab (45 minutes) Analysis & Discussion

Students will discuss the following questions in groups and then write each question with individual answers in the Lab Notebook.

- 1. What does DNA looks like?
- 2. Explain the importance of the nitrogenous bases in DNA.
- 3. If a scientist needs to remove (extract) DNA from the cell, what parts of the cell would be destroyed?
- 4. Propose a method of DNA replication, just as Watson and Crick did in 1953.



Applications

Have each student write about the "gene" the model represents. For fun, students can imagine a new trait (fictional or not) that he/she would like to have.

Assign a creative writing piece, which includes a "recipe" for the student. For example, ¼ cup freckles and a teaspoon of brown hair, with a dash of blue eyes. Include instructions on how to combine these ingredients to get the perfect product!

Discuss how a mutation in the genetic code might be produced, and how that mutation might affect specific traits in an organism.

Explore scientific theories relating to the formation of the DNA molecule and the beginning of life on earth using the film "The Birth of Earth and Ancient Oceans" by the Discovery Channel.

Design a unique DNA model using creative materials to represent each component of the molecule and write a paragraph with interesting facts about the double helix. These models should be displayed in the classroom.

Further Exploration

Explore scientific theories relating to the formation of the DNA molecule and the beginning of life on earth using the film "The Birth of Earth and Ancient Oceans" by the Discovery Channel.

Research historical events and discoveries in history that were possible because of the knowledge we have regarding the structure of the DNA molecule. Encourage your students to be creative with their research.

Students can bring in examples of the double helix that are present in pictures, periodical clippings, and movies. It would be an interesting way to generate discussions about the importance of DNA, and how the DNA molecule has become a part of our everyday lives.

Vocabulary (see glossary for definition)

Nucleic Acids
Deoxyribose nucleic Acid (DNA)
Nitrogenous base
Replication
Complementary base pairing
Adenine (A)
Thymine (T)
Guanine (G)

Cytosine (C) Nucleus Chromosome

Resources

Websites

http://www.dnaftb.org/dnaftb/

The DNA Learning Center's Internet site. Use this site to explore various genetic concepts from inheritance to genetic engineering.

http://www.ygyh.org/

The DNA Learning Center's Internet site.
Use this site to learn about the connection between genes and health.

www.dnai.org

The DNA Learning Center's Internet site.
Use this site to learn about the past, present and future of DNA science.

www.dnalc.org/harlemdnalab/labcenter

The Lab Center, a DNA Learning Center Internet site. Use this site to find applicable links, supplementary information and printable student/teacher materials for the DNA Extraction.

Films:

"The Birth of Earth and Ancient Oceans" Discovery Communications, Inc., 2002.

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