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BASIS Lesson Plan

Lesson Name: Can We See Your DNA?

Grade Level Connections

Next Generation Science Standards

Grade 6, Life Science (MS-LS1-1; MS-LS1-2; MS-LS3-2)

Grade 5, Physical Science (5-PS1)

FOSS Next Generation Edition

Grade 5, Life Science (Living Systems)

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

What makes you look the way you do? Why do the offspring of the same species look alike? Using some easy chemistry and the unique properties of the molecule, we will show your students the molecule behind the instructions for life, DNA!

Lesson Objectives

- After this lesson, students will start to gain an understanding of DNA, the genetic material which defines our physical traits, and how that molecule is replicated.
- The students will have idea of what molecules DNA is made up of, and begin to think about molecules that are small enough to fit inside cells.
- Students will be able to see DNA as they extract the DNA of a banana.

Vocabulary Words

DNA – Deoxyribonucleic acid. The long molecule that exists in every cell's control center that contains all instructions for the cell's jobs.

Genome – All of your DNA.

Chromosome – Chromosomes are super-packed and organized structures of DNA.

Gene – A small portion of the DNA, similar to a cooking recipe that tells the cell what things to make.

DNA Bases – Four different DNA "letters" that spell out genes.

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Materials

Volunteers will bring:

Dry Erase Markers

DNA Worksheet

Colored signs that hang around neck for DNA structure activity

DNA extraction materials:

- Water
- Table Salt
- SDS detergent
- 1 Banana
- 95% Isopropanol (chilled in cooler with ice)
- Eye dropper
- Yarn, scissors, markers
- Plastic Cups
- Ziplock bags

Teachers should provide:

Space for the entire class to be in four lines (ideally at the front of the classroom, but could be in between desks)

Pens/pencils

Classroom Set-Up

Students will be divided into at most 6 groups to ensure that there is at least one volunteer available to supervise each group. There will need to be a space in the classroom for 2 sets of 2 parallel lines of students (so 4 lines total, each with $\frac{1}{4}$ of the class) to demonstrate the structure and replication of DNA. We would like to show a PowerPoint to the class to illustrate some concepts, so some way to connect to a projector (either VGA or HDMI will work). If your classroom is not set up for this, please let us know and we will adjust our presentation.

Classroom Visit

1. Introduction (10 minutes)

Role Model Introduction:

Hello, we are all students and scientists from the University of California, Berkeley. Say our names, how many years we have been in school in the form of your “grade” (1st year of grad school is grade 17), and why you love science.

Topic Introduction:

(Cut an apple, one cut down the middle). Does anyone know what this fruit is called? (An apple). What are these small blackish-brownish ovals in the center? (Seeds). What happens if you plant this seed, what kind of tree will it become? (An apple tree). But how does the seed know to become an apple tree? (Take some guesses...) This was a problem that many scientists asked, and after years and years of work we discovered that there is something inside that seed that tells it to become an apple tree. That same thing is passed down to all offspring from their parents. Do you think we can see what that thing is? (cut open the seed). What tells the seed what to do is actually too small to be seen. It’s a molecule, does anyone know what this molecule is called? It’s called Deoxyribonucleic Acid, or DNA! Can you all practice saying “Deoxyribonucleic acid” with me? (de-OXY-RI-bo-nu-CLE-ic acid) (Go into vocabulary PowerPoint, slides 3-6).

Inside each and every single one of your cells, there are many libraries of recipe books. This library is made up entirely of DNA! The entire library is called “The Genome”, so any recipe you want to make can be found somewhere in your genome. In the human genome, there are 23 pairs of different “libraries” that you can pick your recipe from. These different libraries of the genome are called “Chromosomes”. If you go into one of these libraries and pick a specific book that has something you want to make, that book is called a “Gene”. And finally, the words on the page that tell you how to make that recipe are called “DNA bases”!

Today we’re going to look at the DNA code, how DNA is stored and replicated, and then we are going to look at some banana DNA!

2. Learning Experience (40 minutes)

DNA Code Worksheet (in small groups, maybe 2-5) – 5 min

Some of you may have heard of the DNA code, or the genetic code. Today we are going to learn about the four letters that make up that code: A,T,G, and C. The key thing about the DNA code is that A always goes with T (and T always goes with A), and G always goes with C (and C always goes with G). Did everyone get that? What letter goes with T? (A). What letter goes with C? (G). You can see in the diagram here how the bases fit into each other, so the A and the T fit



together, and the G and the C fit together. One of our volunteers is passing out a short worksheet that has a small story on it, but some of the letters have been replaced! Only the DNA code will help you figure out what the story is about, so work with your groups to figure out the short story! (Hand out “The Cat who wanted to Act” story)

DNA Replication activity (whole class as 1 group, need space for four lines of about 8 students or $\frac{1}{4}$ of the class) – 10 min

Using some very powerful microscopes, scientists have figured out what DNA looks like! Let’s demonstrate what it looks like, but we’re going to need some help. We are going to pass out some placards with string on them, they each have a letter, and a number on them! The letter is the DNA base, and the number is which group you are in. Group 1, please stand up! (arrange students in a group where there is space). Listen carefully! Your first task is to find the DNA letter that matches with your card, so A’s find T’s, T’s find A’s, G’s find C’s and C’s find G’s. Once you find them, shake their right hand and hold on! While still holding the hand of your DNA partner, line up so that your left hand is on the left shoulder of someone who is not your partner. Got it?

Now, let’s write down the order of the letters, and the direction they are facing. (write on the white board) Now, group 1, let go of your right hands, but not your left, and step a few steps apart from each other. Group 2, it’s almost your turn! In a second, you are going to find the DNA letter that matches with your card, so A’s find T’s, T’s find A’s, G’s find C’s and C’s find G’s. Once you find them, shake their right hand and hold on! Now, let’s write down the order of the letters, and the direction they are facing. (write on the white board)

Everyone please take their seats, great job! So what did you notice about the first piece of DNA we made? Were all A’s with T’s and C’s with G’s? Which direction were the two lines facing? Now, what happened when we added group 2? How were the two pieces of DNA that we made similar or different? (they were exactly the same). In your bodies, DNA twists upon itself to form a structure seen here, the double helix, but if you were to unwind it, the structure would resemble the shape you all just made: connections to the right partner, and the two strands facing different ways. And the DNA code is how the molecule is able to perfectly replicate itself, because a copy of DNA can be formed from either half of the original!

Banana DNA Extraction (class in groups, 5 total groups) – 15 min

Now, if we have a lot of cells present, maybe we can make the DNA visible! Be sure to pay close attention to the volunteer who is leading your group! First we will mash up the banana in salt water, the water will suspend the cells, and the salt will help separate the DNA from other things in the cell. Now we are going to break open the cells with some soap! The DNA is in the liquid part here, so we will remove the solid parts with a filter. The DNA molecule is invisible in the water solution, but it clumps up when we add an alcohol, like rubbing alcohol. We will pour this very carefully so that there are two different layers. Do you see this white globby stuff? This is the banana’s DNA!”

(Below originally from “Whole New World” Banana DNA extraction protocol:

* 2mL Eppendorf (EP) tubes with small pieces of banana are prepared in advance.

* Solution A (SDS + salt + water solution) and solution B (90% ethanol) are prepared in advance.

Instructions for students:

- Take one EP tube and one coffee stirrer.
- Open EP tube and squish banana using the stirrer.
- When done, instructor will add solution A (500uL) to it.
- Stir some more, then close EP tube and shake for 10 seconds.
- When done, open EP tube and instructor will add solution B (600uL) to it.
- Close EP tube and shake for 10 seconds.
- Hold still and wait for DNA to precipitate! (the mixture should divide into two layers, a clear top layer and a darker mixture in the bottom.)
- Observe DNA. (it should be seen near the top of the solution, as a white substance.)
- Use marker to put initial and date on the EP tube. (teach students the importance of labeling.)
- Students may use yarn to make a necklace with the EP tube of DNA.

* These instructions are given while one instructor is doing a demonstration using a larger scale (plastic cup).

* The other instructor helps the students with adding solutions and any other difficulties they may be having.

* While shaking, instructors explain what each solution is doing to the DNA. (solution A – breaking down the cells of banana to get DNA out. solution B - to separate DNA from the rest of the solution).

3. Wrap Up: Review and Discuss the Learning Experience (5 minutes)

Does anyone have any questions about DNA or genomes, or genes? Did DNA look the way you expected it to? (it usually isn't in that clumped up form, usually soluble and colorless). Can you think of anything else that has DNA (anything living)? What makes us different from bananas if we both have DNA (different kinds of libraries or different genomes)? What makes two people with the same genome different from each other (different recipe books or genes activated)? Where do people get their DNA from (parents)? Can we see genes on the DNA (no)? Do all fruits have DNA in them (yes)? Do we eat this DNA (yes)? What on the molecular level makes DNA a recipe (different order of bases/letters)? Could we see your DNA? Your teacher has a link that will show you an experiment to see your very own DNA (be sure to follow the directions carefully, because of how many cheek cell you use (not very many), you won't get very much of your DNA to clump up).

4. Connections & Close (5 minutes)

Connections to the real world around students:

DNA is the recipe book for our bodies, and every living thing! The DNA code is the specific bases that DNA uses to store information, and it exclusively uses the letters A, T, C, and G. Because of the unique structure of DNA, it can replicate itself perfectly and keep the exact same order of bases throughout your lifetime!

A final wrap up where every volunteer says what they do in their own research. “I study (*insert topic here*, do any of you know what that is?” Start a conversation with the students.

Thanks and goodbye!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- <http://www.crscience.org/educators/helpfulreports>
- <http://www.crscience.org/educators/treasuretrove>

Suggest students write a letter explaining “What we learned about DNA...”

Reading Connections

- Genetics: From DNA to Designer Dogs by Kathleen Simpson. Illustrated with photographs from various sources. National Geographic Society. 64pp. Trade ISBN 978-1-4263-0361-6, \$17.95; Library ISBN 978-1-4263-0327-2, \$27.90. (I, A) Portraying the work of scientists in the quickly advancing field of genetics, the stories in this book tell about researchers sequencing a mummy’s DNA and investigating the use of human stem cells. It includes an interview with a DNA investigator and superb photographs. Timeline, Glossary, Bibliography, Index. PLB (IV, VII, VIII) <http://www.nsta.org/recommends/ViewProduct.aspx?ProductID=18798>
- Genes and DNA by Richard Walker - Explores modern genetics, from an investigation of genes and their function, to forensics, therapy, and cloning. <http://www.amazon.com/Kingfisher-KnowledgeGenes-Richard-Walker/dp/0753456214/>
- DNA is Here to Stay by Frances Balkwill - From the moment of conception, the DNA strands contained in the chromosomes of our cells are hard at work duplicating themselves, so that the body can make and maintain all the different parts it needs to function efficiently. What DNA does and how it does it is explained by Dr Balkwill's straightforward text and Mic Rolph's

illustrations. This is the third book in a series which introduces microbiology to young readers. The first two titles, "Cells Are Us" and "Cell Wars", won the 1991 Copus Science Book Prize.

<http://www.amazon.com/DNA-Here-Stay-Cells-Things/dp/0876146388>

Other: Students can go home and figure out whether their families and siblings have the same traits as them or different traits and see how genes are passed down. More ideas of traits to look for from website resources.

Have Your DNA and Eat it Too (University of Utah Genetic Science Learning Center) - In this activity, learners build edible models of DNA, while learning basic DNA structure and the rules of base pairing. Learners construct the models out of licorice and colored marshmallows and create labels for the base pairs and backbone. This is an excellent activity to use at the end of a unit on DNA.

http://teach.genetics.utah.edu/content/begin/dna/eat_DNA.html

Origami DNA - In this activity, learners create an origami model of DNA, demonstrating its double helix structure. Two templates are available as PDFs: a standard template with the base pairs already colored or a blank template where the learners have to color the four bases A, C, T and G and mark them in the correct location on the template.

<http://www.yourgenome.org/teachers/origami.shtml>

Family Traits and Traditions (University of Utah Genetic Science Learning Center) - In this activity, learners play a matching game with their families to discover common inherited traits and traditions. Learners distinguish between inherited traits and learned traditions. This genetics activity is available in English and Spanish.

<http://teach.genetics.utah.edu/content/begin/traits/familytraits.html>

Handout: <http://teach.genetics.utah.edu/content/begin/traits/familytraitsandtraditions.pdf>

Banana DNA Extraction Protocol: (adapted from: http://www-tc.pbs.org/wgbh/nova/education/activities/pdf/3214_01_nsn_01.pdf)

1. Mix 1 teaspoon of salt in 50mL of water, and place into a ziplock bag. Add a squirt of soap and a third of a banana. Mash the banana gently to suspend the cells, but avoid creating a foam.
2. Filter a portion of the mixture through a layer of cheese cloth into a clear plastic cup.
3. Pour ice cold isopropanol down the side of the cup without disturbing the bottom layer. Let stand 1 minute and observe the separation that occurs.
4. Dip the wooden skewer into the top layer, slowly rotating it to spool out the banana's DNA.

NOVA Cheek Cell DNA Extraction Protocol: (adapted from:

<https://www.youtube.com/watch?v=DaaRrR-ZHP4>)

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1. Rise mouths with water.
2. Mix 1 teaspoon of salt in 50mL of water. Take a small mouthful of the salt water into your mouth. Chew on your cheek cells to release them into the salt water. Spit gently into a plastic cup.
3. Add a small amount of soap to the cup, and stir gently for 2 min.
4. Pour ice cold isopropanol down the side of the cup without disturbing the layers. Let stand 5 min.
5. Dip the wooden skewer into the bottom layer, slowly rotating it to spool out your DNA!

Standards Connections

NGSS:

- Connections by topic
 - Life Science: MS. Structure and Function
 - Life Science: MS. Growth, Development, and Reproduction of Organisms
 - Physical Science: 5. Structure and Properties of Matter
- Connections by disciplinary core ideas
 - Life Science: MS-LS1. From Molecules to Organisms: Structure and Processes
 - Life Science: MS-LS3. Heredity: Inheritance and Variation of Traits
 - Physical Science: 5-PS1. Matter and Its Interactions
- Connections by scientific & engineering practices
 - 2. Developing and using models
 - 6. Constructing explanations
- Connections by crosscutting concepts
 - 4. Systems and system models
 - 6. Structure and function
- Connections by performance expectation
 - MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to function.
 - 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.