PATTERNS IN DNA

(45 MINUTES)

AT A GLANCE

Students will use everyday materials to extract their DNA from cheek cells and learn about the patterns found in DNA.

OBJECTIVES

- Students will extract DNA from their cells.
- Students will describe two patterns associated with DNA.

KEY VOCABULARY

DNA: Deoxyribonucleic acid is the unique hereditary material in humans and other living things.

NEXT GENERATION SCIENCE STANDARDS

SCIENCE AND ENGINEERING PRACTICES:

- Asking questions and defining problems
- Planning and carrying out investigations

CROSSCUTTING CONCEPTS:

- Patterns
- Scale, proportion and quantity

DISCIPLINARY CORE IDEAS:

- LS3: Heredity: Inheritance and Variation of Traits

ADVANCE PREPARATION

Place isopropyl alcohol in the refrigerator.

MATERIALS PER GROUP

Salt packet
Dixie cup
Test tube
Pipette
Cold isopropyl alcohol
Liquid soap
Wikistix (Optional)

WHAT YOU NEED TO KNOW

DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other organisms. With the exception of red blood cells, every cell in the body has DNA and every cell in a person's body has the same DNA. Most DNA is located in the cell nucleus, but a small amount of DNA can also be found in the mitochondria. The only people with the exact same DNA are identical siblings.

DNA provides the instructions for building and operating all living things. The 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 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 are represented with A,T,C and G. The bases form pairs in a very specific way, A-T and C-G.

DNA is very long. It can only fit into a cell by being packaged up into small units called chromosomes. Chromosomes are the storage space for DNA, and they are what can sometimes be seen in a microscope when looking at a cell. Humans have 46 chromosomes in each cell. Each parent gives a person 23 chromosomes, or half of their genes. Genes are what give people their specific traits, ranging from eye color and hair color to whether or not they are prone to certain diseases. Scientists have discovered that genes are inherited in certain patterns. For example: if a woman has red hair, a man has black hair and their child has black hair, where did the child's black hair gene come from? The father.

In this activity, students will see their own DNA. Keep in mind that the DNA you see in this activity is actually clumps of thousands of strands of DNA. To see the individual strands of DNA, you would need an electron microscope.

WARM UP

Have a discussion with students. Ask them: Is it true that every living thing is made of cells?

Yes, this is true. In fact, humans and other animals share the exact same cell structure. Our cells are identical.

Why is it then, that we look completely different from a cat? And how come we don't look exactly like the person sitting next to us?

The answer is DNA, deoxyribonucleic acid, known as the blueprint of life. DNA carries a coded set of instructions that tell our cells how to arrange proteins. The way these proteins are put together determines everything from our eye color to which cells become our liver cells.

Ask students to think about where DNA is stored in our cells—in the nucleus. Each cell has a nucleus that contains an exact copy of our DNA. But is there a way to get a closer look at DNA? What would we have to do?

ACTIVITY

1. Divide students into groups. Tell students they will do an experiment in which they extract DNA from the cell nucleus, and that they will be able to see DNA by scraping their check cells.
2. Give each student one cup and one salt packet.
3. Empty the salt packet into the cup and fill the cup about one-quarter full with water.
4. Pour the salt water solution into your mouth and swish vigorously for 45 seconds. Spit the solution back into the cup.
5. Pour the solution from the cup into the test tube, filling the test tube halfway. Discard the rest of the salt water solution.
6. Add four drops of liquid soap to the test tube. Close the tube, gently hold it and swirl it in a circular motion for about one minute.
7. Use a pipette to slowly fill the rest of the test tube with the isopropyl alcohol. The alcohol should float above the liquid soap solution.
8. Let the solution stand for 30 seconds to one minute. Then use the pipette to slowly move the alcohol into the liquid soap layer. You should see long white strands—this is DNA.
9. Explain that each cell contains a long strand of DNA in this ladder-type formation. The shape of the DNA strand is twisted inside our cells. This twisted ladder formation is called a double helix.

CHECK FOR UNDERSTANDING

Have students answer the following questions in their teams or as a whole group discussion.

- What is DNA?
- Where was the DNA stored in the cell?
- What separated the DNA from the cell?
- Why did you add alcohol and liquid soap?

WHAT'S HAPPENING?

Salt helps loosen cells from the surface of the inside of the mouth. The salt also helps shed the water molecules from the DNA and makes it easier for the DNA to clump together.

Think about when you wash dishes–what does the soap do to the oil on the dishes? It breaks the oil up. Cell membranes are also made of lipids. By adding soap to your cheek cells, it breaks up the membranes of the cell and nucleus and frees the contents of the cell, including DNA. So the DNA begins to float near the top of the soapy water.

DNA is soluble in water but not in alcohol. The alcohol helps the DNA precipitate or separate as a solid from a liquid solution. The result is a white clump of thousands of DNA strands that you can see with your naked eye.

By swirling the salt water in your mouth, you collected a great deal of cells from the inside of your cheeks. Salt also bonds with DNA and helps the DNA strands stick together. By spitting those cells (along with the salt water and saliva) into the test tube and mixing them with soap, you were able to break up the outer membrane and nucleus of each cell.

The cell membranes and the nuclear membranes are made up of lipids (very similar to fats). The dish soap that you added dissolved these lipids, thus exposing the DNA. This DNA then floats up through the soap until it hits the alcohol solution. DNA can't dissolve in cold alcohol, so it separates from the solution and forms the long white strands at the bottom of the layer of alcohol.

DIFFERENTIATED INSTRUCTION

- It's also possible to extract DNA from food, such as peas and strawberries. After students are done extracting their own DNA, have them research and complete this process.
- Simplify vocabulary and instructions. Students of all ability levels will be able to participate in some way. Students with taste or texture sensitivities can use another student's DNA sample.

EXTENSIONS

Build a DNA model to better understand the patterns in DNA. Start with two orange Wikki Stix, and press them tightly together, along their entire length. Do the same with two bright blue Wikki Stix. These become the sides, which are actually a linked chain of sugar and phosphate molecules. Lay the two sets down, 2 inches apart.

To make the bases, start with dark blue and purple, cutting them to equal sizes and press them together in the middle, making the span long enough to reach the two sides of the "ladder." Attach them to the sides.

Then use yellow and green and follow the same directions, attaching the base to the sugar phosphate "ladder" slightly below the dark blue and purple. For the fourth bases reverse the yellow and green colors, and attach to the ladder. You now have the pattern for the four bases and can alternate them.

When completed, pick up the "ladder" and gently twist it. The resulting shape is called a double helix.

PATTERNS IN DNA

INSTRUCTIONS

1. PROVIDE ONE CUP AND ONE SALT PACKET PER PERSON.
2. EMPTY THE SALT PACKET INTO THE CUP.
3. FILL THE CUP ONE QUARTER FULL WITH WATER AND SWIRL TO MIX.
4. SWISH THE SALT WATER IN YOUR MOUTH FOR 45 SECONDS AND SPIT IT BACK IN THE CUP.
5. POUR THE SOLUTION FROM THE CUP INTO THE TEST TUBE, FILLING THE TEST TUBE HALFWAY.
6. DISCARD THE REST OF THE SOLUTION INTO A SINK OR TRASHCAN.
7. ADD FOUR DROPS OF THE LIQUID SOAP INTO THE TEST TUBE. CLOSE THE TUBE AND GENTLY ROCK IT BACK AND FORTH OR SWIRL IT FOR ABOUT ONE MINUTE.
8. USE A PIPETTE TO SLOWLY FILL THE REST OF THE TEST TUBE WITH THE ISOPROPYL ALCOHOL. THE ALCOHOL SHOULD FLOAT ABOVE THE LIQUID SOAP SOLUTION.
9. LET THE SOLUTION STAND FOR 30 SECONDS TO ONE MINUTE. YOU SHOULD SEE LONG WHITE STRANDS—THIS IS DNA.