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Teaching DNA Extractions from Fruits (Strawberry, Banana, Kiwi, and Watermelon)

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i-LEARN TEACHING RESOURCES

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Summary: All living organisms are made up of cells that have deoxyribonucleic acid or DNA, as the hereditary material. DNA is a large molecule with a double helix of two twisted ribbons. Most people do not think that they can see DNA, but it is visible when collected from many cells. This activity will demonstrate how DNA can be isolated from multiple fruits using household items. Supplementary PowerPoint lecture presentation is also included.

Lesson Description: In this lesson, students will use a simple DNA extraction solution and isopropyl alcohol to extract DNA from strawberries, banana, kiwi, and watermelon. The extraction solution consists of dish detergent, water, and table salt. Grinding or crushing the soft fruit tissue will separate the cells. The dish detergent breaks down the membranes, exposing the DNA to the solution. The salt helps the DNA molecule to stick together from the proteins. The cold alcohol dissolves everything but the DNA, which forms an insoluble layer of the DNA allowing it to be visible.

Grade Level: 9-12

Estimated Time for Completing Activity: One 50 minute period

Learning Outcomes:

- Students will extract DNA from four fruits using common household items.
- Students will learn functions of each of the ingredients used in the DNA extraction protocol.
- Students will compare the amount of DNA from approximately the same amount of fruit chunks.
- Students will gain understanding of the structure and function of DNA.

South Dakota Standards of Learning:

- HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
- HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Prerequisite: None

Materials:

- 1 Large beaker or paper/plastic cup
- 4 Small beakers or small paper/plastic cups
- Stirring stick
- Tweezers
- Strainer / coffee filter
- Four Ziploc sandwich bags (one for each fruit type)
- 4 different types of fruits – Strawberry, Banana, Kiwi, Watermelon
- Four plastic knives
- Extraction solution (1 cup of water, 1 tablespoon of salt, 1 tablespoon of dish detergent)
- **Chilled** isopropyl or ethyl alcohol or rubbing alcohol

Vocabulary:

- Central Dogma of Life
- DNA
- RNA
- Protein
- Transcription
- Translation
- Molecule
- Gene
- Phosphate
- Double Helix

Lesson Links:

- https://www.youtube.com/watch?v=RtTZNTil4Tw

Background:

All living organisms have hereditary material called deoxyribonucleic acid or DNA in their cells. Each DNA molecule consists of two twisted ribbon-like structures forming a double helix. These ribbons are made up of sugars and phosphate backbones, joined by four types of nucleotides or bases: adenine (A), thymine (T), guanine (G), and cytosine (C). An A on one strand always pairs with a T on the other strand, and a C always pairs with a G. These four letters make our genes (i.e., a piece of DNA that encodes a trait), and the arrangement and number of these letters vary from genes to genes. A ribonucleic acid (RNA) is a single stranded structure with four bases A, C, G and U (Uracil). The Central Dogma of life states that information in DNA is copied in the bases of RNA, which in turn is converted into amino acids of a protein. The flow of information from DNA to RNA is called ***Transcription***, while that from RNA to Protein is called ***Translation.*** A combination of three bases on the DNA or RNA makes a codon (a triplet) on the genetic code. There are altogether 4^3 or 64 codons in the genetic code. The codons correspond to 20 different amino acids or stop signals during protein synthesis. The arranged order is important because it tells cells which proteins to make.

Procedure:

Interest Approach:

- Start the lesson by a large group discussion.

  What is DNA? What does DNA stand for?

  DNA stands for deoxyribonucleic acid. It is a hereditary material, which carries genetic instructions on how to make a living organism.

  What does DNA do?

  Our genes are made up of a segment of DNA, which contains unique arrangements and combinations of nucleotides.

- Although you may think DNA is too small to see, it can be seen by the naked eye when collected from thousands of cells.

Procedure:

- Students will be assigned to two or more groups, each to complete the DNA extraction exercise (Group based on the class size). Students will then be given materials (see material list). Students will then complete an experiment as a class following a teacher demonstration. The entire class will follow the **DNA Extraction Protocol** using first the strawberry, then the banana, kiwi, and watermelon. Students will be made sure to label each beaker of each fruit used.

- **DNA Extraction Protocol**

<u>**Step 1**</u>: Place a piece of fruit into a Ziploc bag. The amount of fruit placed in the bag should be the same weight to compare the DNA yields from different fruits. Below is the amount of fruit that we used had similar weight:

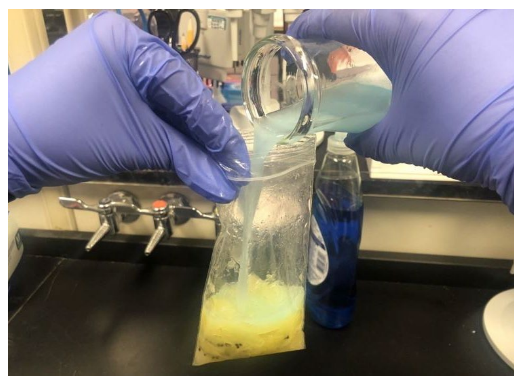
- Strawberry = 1 whole strawberry
- Banana = 1/3 of banana
- Kiwi = ½ of kiwi
- Watermelon = 2 or 3 pieces of cubed watermelon

Remove air in a Ziploc bag and crush the fruit with the fingers.

Why do we crush the fruit?

In this step, students should understand that they are breaking down the fruit's tissues so that cells are separated.

<u>**Step 2:**</u> Add 3 tablespoons of extraction solution (Extraction Solution = 1 cup of water, 1 tablespoon of salt, 1 tablespoon of dish detergent).



Ask the students the following questions:

What is the purpose of mixing salt in the solution?

Salt ensures that the proteins of the cell are kept separated from the DNA. Salt allows DNA molecules to come closer to each other, so they stick to one another.

What does the dish detergent do?

Dish detergent breaks down the cell and nuclear membrane exposing the DNA

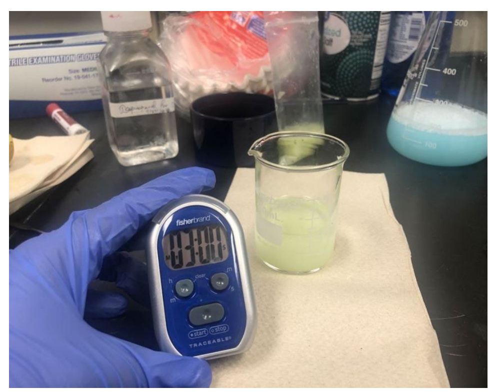
Crush and mix fruit and solution together. (Note: Crush the fruit and solution with your hands. Do not use hard surfaces to mash the solution as this might damage the DNA strands.)

Step 3: Place strainer or coffee filter over a small beaker (paper cups can be used in place of a beaker).

Step 4: Pour the fruit mixture over the strainer and into a small beaker.

Step 5: Add the same volume of chilled isopropyl to the small beaker. Be sure to pour alcohol down the inside of the beaker so the liquids don't mix.

What is the purpose of the isopropyl alcohol?



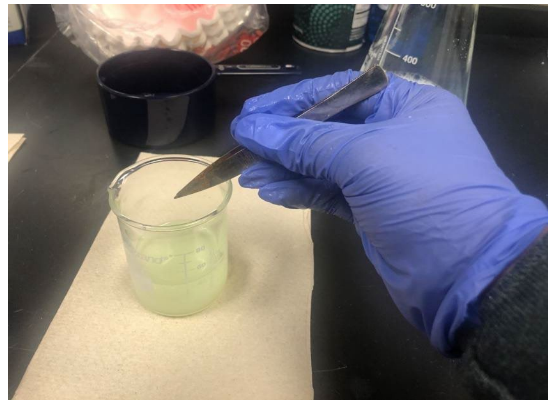
Isopropyl alcohol precipitates DNA.

Step 6: Allow the beaker to sit for 3 minutes and observe what happens to the alcohol layer.

Time allows DNA to rise as an insoluble layer. During the 3 minutes, students can observe the DNA move to the top layer of the mixture.

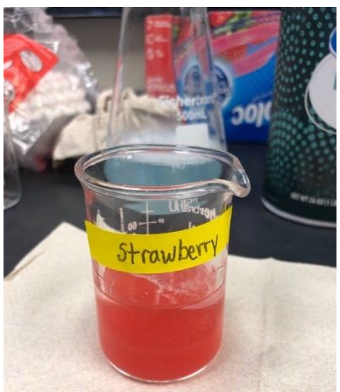
<u>Step 7</u>: Use tweezers to pull out the white thread-like DNA from the solution. You may not be able to pull out DNA in some fruit mixtures.

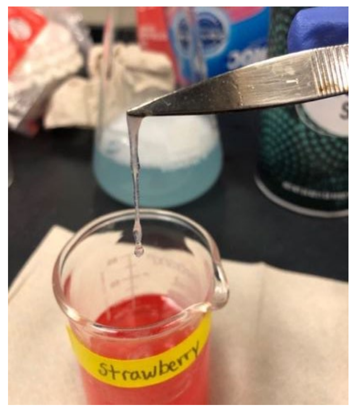
You will see a white thread-like cloud appear at the top layer of the mixture. This is the fruit's DNA.



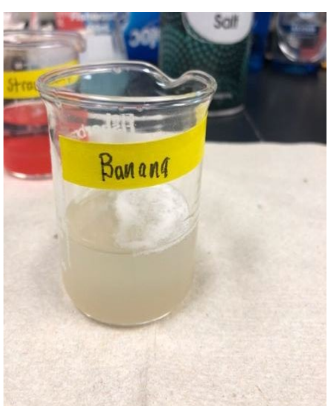
Results

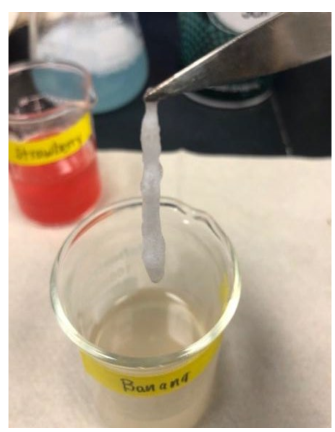
Strawberry DNA





Banana DNA





Kiwi DNA

Assessments

Sketch fruit DNA extraction in each box.

Strawberry:	Banana:
Kiwi:	Watermelon:

What are some differences / similarities between the fruit DNA extractions?

Which fruit were you able to extract the most DNA from? The less?

Sketch the double-stranded structure of DNA, and label sugar, phosphate, nitrogen bases and hydrogen bonds.

What did you learn from today's activity (Think-pair-share)

(Students will complete the worksheet, label the drawings/sketch of their findings, and discuss the structure and function of the DNA before leaving the classroom).

Extensions: Gene Electrophoresis, Restriction Fragment Length Polymorphism, Polymerase Chain reaction

Teacher Notes:

- Mix extraction solution before attempting experiment
- Make sure that isopropyl is refrigerated
- Disclaimer: Food Allergy
- Consider using dark colored coffee filters and some other ways to quantify the amount of DNA or measure of quality of DNA
- Take a picture of the total DNA floating on the solution for each of the extraction. Place the original Images on a graph paper and quantify them. Ask students a question, whether or not there would be a correlation between fruit size and DNA yields.

Assessment:

- DNA Extraction Comparison Worksheet
- Discussion questions during and after the hands-on

Accompanying Resource: PowerPoint Presentation

References

- https://imb.uq.edu.au/files/32865/Strawberry%20DNA%20Extraction.pdf
- https://www.genome.gov/Pages/Education/Modules/StrawberryExtractionInstructions.pdf
- https://kids.britannica.com/kids/article/DNA/390730

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