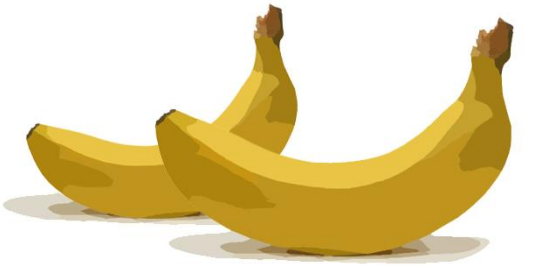
Seeing Banana



Banana DNA Extraction Activity

Ask A Biologist activity for classroom and home

Table of Contents

Learn more

This is a companion PDF for these online articles and activities:

http://askabiologist.asu.edu/activities/banana-dna

https://askabiologist.asu.edu/explore/dna-abcs

http://askabiologist.asu.edu/getting-genetics-straight

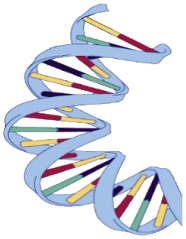
https://askabiologist.asu.edu/explore/gene-expression

Other Options

This is our spin on a classic activity. There are many DNA extraction protocols that can be found on the Web. One in particular we like is by NIH – Genome Unlocking Life's Code. It uses strawberries instead of bananas.

https://unlockinglifescode.org/node/653

Overview



All living things, bananas and people included, pass on information from one generation to the next using the same basic material, DNA. Within every living organism, most cells contain a complete set of DNA instructions. The information in DNA tells our bodies how to develop, grow, and work. It also controls many of the features that make an organism unique. These instructions are in segments of DNA called genes. Genes, along with other parts of our DNA that turn genes on and off, hold information for how our body develops and functions. They produce molecules called proteins that do most of the work in the body. Variants of genes, called alleles, are responsible for differences in hair color, eye color, and earlobe shape.

All of these instructions fit within tiny packages within our tiny cells, so that is all way too tiny for anyone to ever really see or touch, right? Well, not entirely. Because DNA is in every cell, there is a lot of it in an organism. If you took all of the DNA out of some middle-sized organism (or part of an organism, like a piece of fruit), you could see and even touch DNA. We will use common household products to break apart the cells in a banana and extract out the DNA. While you may know of the double-helix structure of DNA (it looks kind of like a ladder twisted into a spiral shape), you can't see that structure with the naked eye. So when seeing it without a high-powered microscope... what does DNA look like?

Materials

- ½ peeled ripe banana (you can also use strawberries and other fruit)
- ½ cup hot water
- 1 tsp salt
- ½ tsp liquid dishwashing soap
- Resealable zip-top bag (quart size)
- Very cold rubbing alcohol (isopropyl alcohol) and place in freezer ahead of time.
- Coffee filter
- Narrow glass
- Wooden stirrer

Companion step-by-step video of the entire activity - **askabiologist.asu.edu/activities/banana-dna**

Extracting DNA in 10 Easy Steps

There is also a separate student instruction sheet on page 4

1. Mush half of the banana in the zip bag for about a minute until all the lumps are gone and it looks like pudding.
2. Fill a cup with the hot water and salt.
3. Pour the saltwater mix into the bag. Close the bag and very gently squeeze and move the saltwater and banana mush together. Do this for 30 to 45 seconds.
4. Add the dishwashing soap into the bag and gently mix the contents. Avoid making too much foam.
5. Place the coffee filter in a clear glass cup, securing the top of the filter around the lip of the cup.
6. Pour the mix into the filter a little bit at a time to avoid breaking the filter. Let it sit until all of the liquid drips down into the cup.
7. Remove and throw away the used coffee filter.
8. Tilt the glass and **slowly** add cold alcohol down the side of the cup. You want the alcohol to form a layer on top of the banana mix, staying separated, so be careful not to pour it too fast. Make a layer of alcohol that is 2.5-5cm (1-2in) thick.
9. After the alcohol layer is set up, wait for eight minutes. You may see some bubbles and cloudy material moving around in the alcohol. This material is DNA clumping together.
10. Use the wooden stirrer to start poking the cloudy stuff in the alcohol layer. Spin the stirrer it in place to start gathering the cloudy stuff. When you are done, take a closer look at the stuff on the stirrer. You are looking at DNA!

What Happened?

You may understand that mashing a banana can break cells apart and help break apart cell walls, but why was all that other stuff added? And how did we get inside the cells and get the DNA to stick together?

Let's think of three of the main items we added to the bananas.

1. **Saltwater** - The bananas were mashed with saltwater before anything else was added. But this was a special step preparing for the addition of the dish soap. Once the dish soap helps release the DNA, this salt will help the DNA strands to stick to each other in clumps large enough for you to see.

2. **Dish soap** - Dish soap can break apart a type of molecule called lipids. Think of fats and oils. Dish soap "cuts through grease" because it actually breaks down those greasy molecules. Now, the molecules that make the membranes around cells and the nucleus (which holds DNA) are lipids. So when dish soap is added, the cell membrane and the nuclei are broken apart, releasing the DNA.

3. **Alcohol** - The DNA clumps are soluble (can be dissolved) in some liquids, but not in alcohol. So adding alcohol helps the clumps of DNA to form. DNA doesn't dissolve in alcohol, so this step helps DNA clumps form.

Extracting **DNA** from a  in 10 Easy Steps

Before you begin - Make sure the alcohol (isopropyl alcohol) is in the freezer getting cold and check each box after you complete each step. ☑

Remove the banana peel and mush half of the banana in the zip bag for 1 minute. ☐

Fill a cup with the hot water (1/2 cup) and salt (1 teaspoon). Stir until the salt is dissolved. ☐

Add the saltwater to the bag and close it. **Gently** mush the water and banana for 45 seconds. *The salt will help the DNA stick together once it is out of the cells.* ☐

Add the dishwashing soap into the bag and **gently** mix, trying not to make it foam up. *The soap breaks apart the cell membrane and the cell parts that hold the DNA*. ☐

Place the coffee filter in a clear glass cup, securing the top of the filter around the lip of the cup. ☐

Pour the mix into the filter a little bit at a time to avoid breaking the filter. Let it sit until all of the liquid drips down into the cup. This can take a while. ☐

Remove and throw away the used coffee filter. ☐

Tilt the glass and **slowly** add cold alcohol down the side of the cup. You want the alcohol to all stay on top of the banana mix in a layer that is 2.5 to 5 cm (1 to 2 inches) thick. ☐

Wait for 8 minutes. You may see some bubbles and cloudy material moving around in the alcohol. *DNA doesn't dissolve in alcohol, so this step helps DNA clumps to form.* ☐

Using the wooden stirrer, poke the cloudy stuff in the alcohol layer and then spin the stirrer in place to start gathering the cloudy stuff. The stuff on the stirrer is DNA! ☐

Questions to think about after extracting banana DNA (write you answers below).

What did the DNA look like?

Do you think you used one ingredient that was more important than the others? Why?

Name five things that would not have DNA.

If you could take all the DNA out of your body, would it fit on a plate? If not a plate, what would it fit in?

For Teachers

This short activity helps students visualize one of the most important molecules on the planet, DNA. The activity can be done with simple materials found in most homes. We use bananas, but strawberries or other fruit soft enough to mush up can also be used. The activity is written for students at a middle school or higher level, but with more intense guidance, this activity is useful for students of any age.

Tips for Classroom Implementation
Time Required: 45 minutes

Classroom set-up

- One container of soap and salt should be more than enough for a large class to use, but we suggest having two of each on hand just in case.
- This activity generally works better with small groups of students each working on their own banana extraction. This also makes it likely that at least one group will have very visible DNA.

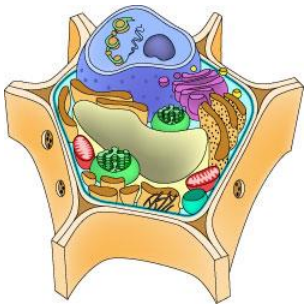
Tips

- Make sure to have extra zip bags and extra coffee filters on hand, in case any break.
- If a coffee filter breaks and banana mush falls to the bottom of the glass, pour it back into the bag, secure a new filter, and pour the mush back in more slowly, letting it drain as you pour.

Extensions
When combined with additional reading from Ask A Biologist, or additional short assignments, this DNA extraction activity can meet several learning standards.

Genetic

- The story "DNA ABCs" will help students understand the importance of DNA to life, as well as the chemical and physical structure of DNA. http://askabiologist.asu.edu/explore/dna-abcs
- The story page "Getting Genetics Straight" will help students differentiate between genes and chromosomes, and understand alleles. http://askabiologist.asu.edu/getting-genetics-straight
- For high school students, the story "Controlling Genes" will help them understand protein synthesis. https://askabiologist.asu.edu/explore/gene-expression
- Students can try to figure out how much DNA is in an adult human body. You can either provide the following information to them, or have them search for it online:
    - ~37 trillion cells in an adult human body (3.7×10^{13})
    - 6.5 pico-grams of DNA per cell (6.5×10^{-12})
    - ~250 grams of DNA or more (~9 ounces)



Cellular

- The story "Building Blocks of Life" will help students understand the cell structure and function. https://askabiologist.asu.edu/explore/building-blocks-life
- The story "Cells Living in Cells" will help students understand the different cell types that exist. https://askabiologist.asu.edu/explore/cells-living-in-cells

Objectives

1. Students will grasp that small molecules are tangible.
2. Students will follow directions and understand that basic chemicals (salts and detergents) can be used to break down cells and cell parts and to make molecules stick to other molecules.
3. EXTENSION: Students will gain a basic understanding of the structure of DNA.
4. EXTENSION: Students will understand cells and that they broke apart the cell membrane and the nuclear membrane to reach the DNA.

Standards

Next Generation Science Standards

High School Life Sciences

HS-LS-1.A: Structure and Function. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.

Arizona Science Standards

Strand 4: Life Science

Concept 1: Characteristics of Organisms

Kindergarten PO 1. Distinguish between living things and non-living things.

Grade 6 (Cellular Extension) PO 2. Describe the basic structure of a cell, including: cell wall, cell membrane, and nucleus.
(Cellular Extension) PO 3. Describe the function of each of the following cell parts: cell wall, cell membrane, and nucleus.
(Cellular Extension) PO 4. Differentiate between plant and animal cells.

Concept 2: Molecular Basis of Heredity

Grades 9 – 12 (Genetic Extension) PO 1. Analyze the relationships among nucleic acids (DNA, RNA), genes, and chromosomes.
(Genetic Extension) PO 2. Describe the molecular basis of heredity, in viruses and living things, including DNA replication and protein synthesis.

Common Core standards:

Grades 6 - 8:

CCSS.ELA-LITERACY.RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

CCSS.ELA-LITERACY.RST.6-8.10
By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.

DNA basics: 8th grade
Getting genetics straight: 8th grade
Building blocks of life: 7th grade

Grades 9 - 10:

CCSS.ELA-LITERACY.RST.9-10.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CCSS.ELA-LITERACY.RST.9-10.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Controlling genes: 9th grade
Cells living in cells: 10th grade