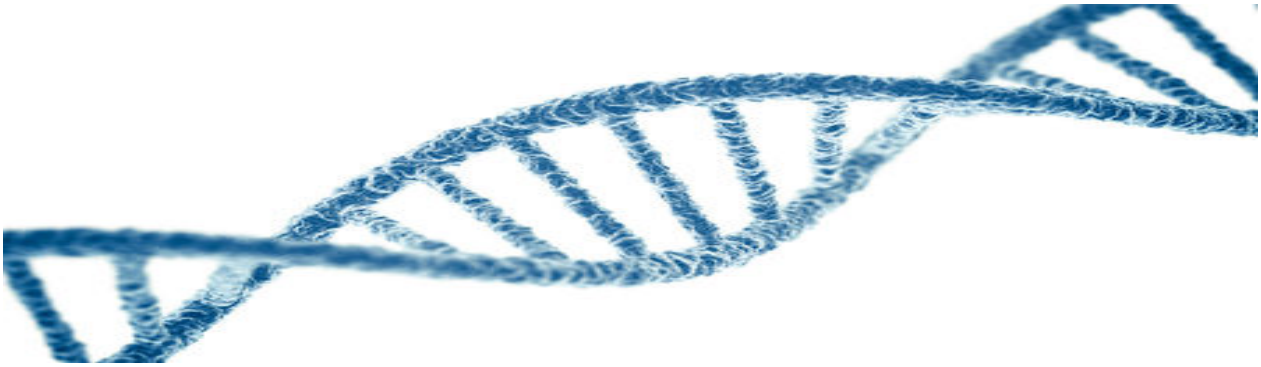
# Lab Practice: Extracting DNA from a Banana



**Teacher's Summary:**

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 in the text, but strawberries or other fruit soft enough to mush up can also be used instead. 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.

**Educational Standards:**

*Next Generation Science Standards*

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.

Science and Engineering Practices: Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Science and Engineering Practices: Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematic

*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.

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.

**Learning Outcomes**:

This lesson introduces and reinforces use of research vocabulary. Scientific practices guide students through a modeling activity that teaches them to identify lab research patterns, data accumulation, and synthesis. Students conduct intentional lab practices and techniques to acquire data and to compile information.

After completing this lesson, students should be able to:

- Students will grasp that small molecules are tangible.
- 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.
- Students will gain a basic understanding of the structure of DNA.
- Students will understand cells and that they broke apart the cell membrane and the nuclear membrane to reach the DNA.

# Lab Practice: Extracting DNA from a Banana

**Introduction:**

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. All living things, bananas and people included, pass on information from one generation to the next using this same basic material, DNA.

DNA or deoxyribonucleic acid is found in all living things. Its natural shape is called a double helix and when seen under extremely high-powered microscopes, it looks kind of like a ladder twisted into a spiral shape.

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, you can't see that structure with the naked eye. So when seeing it without a high-powered microscope...what does DNA look like?

**Duration:**
45 minutes

**Materials**

- 1/2 peeled ripe banana (you can also use strawberries or other fruit)
- 1/2 cup hot water
- 1 tsp salt
- 1/2 tsp liquid dishwashing soap
- Cup
- Resealable zip-top bag (quart size) *Make sure to have extra zip bags and extra coffee filters on hand, in case any break.*
- Very cold rubbing alcohol (isopropyl alcohol) placed in freezer ahead of time
- Coffee filter
- Narrow glass
- Rubber Band
- Wooden stirrer

*Suggestions*: One container of soap and salt should be more than enough for a large class to use. Have two containers of very cold isopropyl alcohol on hand.

This activity generally works better with small groups of students, or with individual students each working on their own banana extraction. This also makes it likely that at least one group will have very visible DNA.

*Tip:* 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.

**Steps:**

1. Review the procedure with students, discussing key terms and responding to any questions. Explain that crushing the bananas separates its cells and exposes them to the soap and salt. The soap helps break down cell membranes and release DNA. The salt helps bring the DNA together, and the cold alcohol helps the DNA precipitate and come out of solution so it can be collected.

2. Demonstrate the following:
   • Show what it means to stir gently so as not to cause the solution to froth or foam.
   • Demonstrate how to place and secure the coffee filter in the cup with the rubber band so that spaces remains for the solution can pass through the filter and be collected in the cup. Leave about one to two inches between the bottom of the cup and the bottom of the filter.

3. Remind the students of the following:
   • Remind students to get their alcohol only when they are ready to use them. It needs to stay very cold until just before pouring.
   Remind the students to pour the alcohol SLOWLY along the tipped side of the glass with the bananas mixture. The goal is to not MIX but to create a separate layer of alcohol floating above the banana mixture.
   • Remind students of the importance of following the procedure carefully.

4. Divide the class into teams.
   Have students gather their materials and begin their extraction. Consider keeping the blenders, the beaker with the alcohol test tubes, a gallon of distilled water, the soap, and the salt in one general area. You may also want to prepare a batch of blended bananas for the entire class and distribute the mixture to teams. Make sure students know to answer the questions at the bottom of the student sheet after finishing the extraction.

# Extracting DNA from A Banana

1. Mush the banana in the resealable bag for about a minute until all the lumps are gone and it almost looks like pudding. You can do this also with other soft fruit that you can mush up like strawberries.
2. Mix the hot water and salt in a cup.
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. Try to 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 with rubber bands.
6. Pour the mix into the filter and let it sit until all of the liquid drips down into the cup. Be patient, this could take a few minutes.
7. Remove and discard the used coffee filter and contents.
8. Tilt the glass and **slowly** add cold alcohol so it streams down the side of the cup (don't pour in directly into cup). You want the alcohol to form a layer on top of the banana mixture, staying separated, floating on top of it, so be careful not to pour it too fast. Make a layer of alcohol that is 2.5-5cm (1-2 inches) thick. It is important that the alcohol is very cold when you pour it so make sure you keep it chilled until you are ready to use it.
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. These are the DNA pieces 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, pull the stirrer out to take a closer look at the stuff on the stirrer. You are looking at DNA!

**Summary**

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.

## Vocabulary

***DNA***: Deoxyribonucleic acid, which is the hereditary material in cells that contains the instructions for producing the cell and enabling it to function

***Extraction***: A procedure to obtain a substance by chemical or mechanical action

***Filtrate***: The material collected after a solution or mixture passes through a filter

***Genes:*** a distinct sequence of nucleotides forming part of a chromosome, the order of which determines the order of monomers in a polypeptide or nucleic acid molecule which a cell may synthesize.

***Lipids:*** any of a class of organic compounds that are fatty acids or their derivatives and are insoluble in water but soluble in organic solvents.

***Precipitate***: Solid material that comes out of solution as a result of a chemical or physical change

***Organism***: an individual animal, plant, or single-celled life form

***Molecules***: a group of atoms bonded together, representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction

## Student Questions

1. What did the DNA look like?
2. Summarize the main steps involved in extracting DNA from bananas.
3. Do you think your results would be different if you were to use a fruit or vegetable other than bananas? Explain
4. Do you think you used one ingredient that was more important than the others? Why?
5. Name five things that would not have DNA.
6. 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?