

DNA Spooling with Strawberries

Student Guide

Introduction and Background

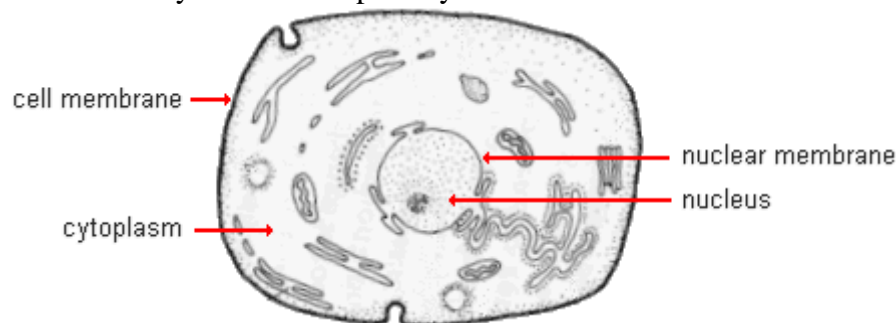
To extract cellular DNA from strawberries, you must break down the cell wall, the cell membrane and the nuclear membrane. Crushing the strawberry in the buffer solution helps to break down the cell wall. The detergent in the buffer solution helps to dissolve the phospho-lipid bilayers of the cell membrane and nuclear membrane, releasing the DNA from the nucleus. The salt contained within the buffer solution helps keep the proteins in the extract layer so they aren't precipitated with the DNA. Once DNA is released from the nuclear membrane, ice cold ethanol causes the DNA to precipitate out of solution. DNA is not soluble in ethanol. When molecules are soluble, they are dispersed in the solution and are therefore not visible. When molecules are insoluble, they clump together and become visible. The colder the ethanol, the less soluble the DNA will be in it yielding more visible "clumping." This is why it is important for the ethanol to be kept in a freezer or ice bath.

Guiding Questions:

1. Where is DNA found in the cell?
2. Is it possible to see and touch DNA?

Vocabulary

Cell: a complex unit of protoplasm, usually with a nucleus, cytoplasm, and an enclosing membrane. All plants and animals are composed of one or more microscopic cells. The smallest organic unit capable of carrying out all of the functions normally attributed to life is a cell. See eukaryotic cell and prokaryotic cell.

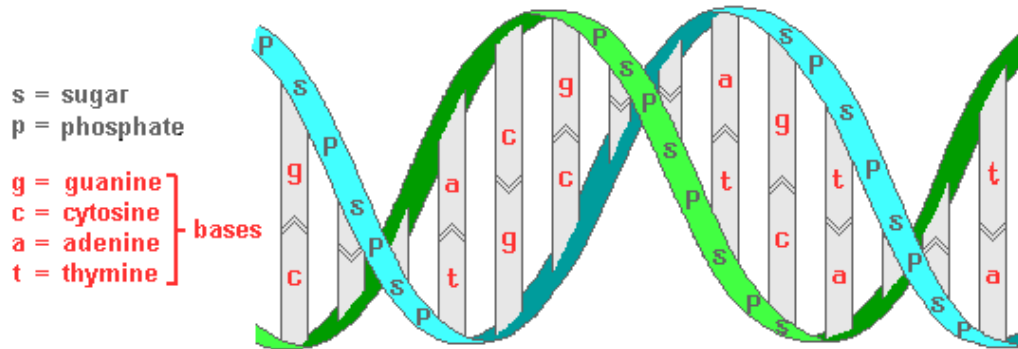


Cell membrane: the selectively permeable membrane enclosing a cell.

DNA:(deoxyribonucleic acid) a large organic molecule that stores the genetic code for the synthesis of proteins. DNA is composed of sugars, phosphates and bases arranged in a double helix shaped molecular structure. Segments of DNA in chromosomes correspond to specific genes.

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Nuclear membrane: the selectively permeable membrane enclosing the nucleus of a cell.

Nucleus: a structure (organelle) found in all eukaryotic cells. It contains the chromosomes (nuclear DNA) and is enclosed by a nuclear membrane.

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Materials (per student group)

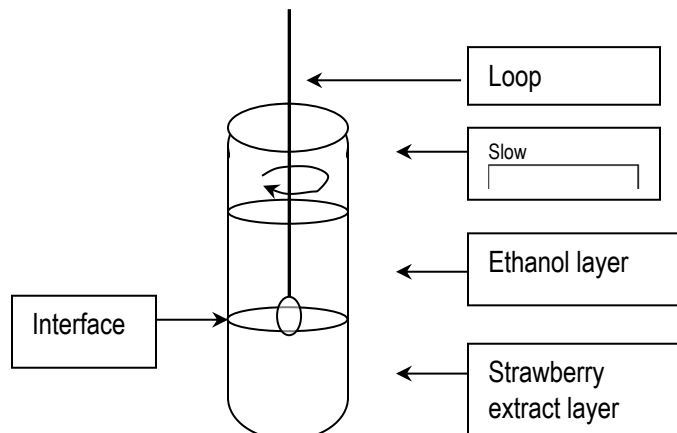
- Heavy-duty Zip-lock bag
- 1 strawberry (fresh or frozen)
- DNA extraction buffer solution (soapy, salty water)
- Filtering apparatus: cheesecloth, funnel, small beaker (or a coffee filter)
- Ice cold ethanol
- Clear test tube
- Glass stirring rod or plastic coffee stirrer (inoculating loops work well too)
- Microscope (optional)
- 2 tooth picks (optional)

Safety

The materials used in this lab should not be consumed. Care should be used when handling lab equipment and consumables. Students should wear safety goggles.

Procedures

1. If the green leaves on the strawberry have not yet been removed, do so by pulling them off.
2. Put the strawberry into the Ziploc bag and mash for about two minutes. You need to **completely** crush the strawberry. You do not want this mixture to be really bubbly. The less bubbles the better. Your mixture should look like a strawberry smoothie when you are done with step 2.
3. When you're finished mashing, put 10 ml of the DNA extraction liquid into the bag.
4. Mash for another minute. Be careful not to make too many soap bubbles.
5. When you're finished, place the coffee filter over a small beaker.
6. Open the bag and pour the mixture into the coffee filter. Allow to filter for several minutes until you have about 3ml of clear, pink liquid.
7. Pour about 3ml into a test tube.
8. Next, carefully pour 5ml ice cold ethanol into the test tube.
9. Watch for the development of several large air bubbles that have a white cloudy substance attached to them. The cloudy substance is DNA!
10. Take the looped rod and stir slowly like you're making cotton candy. If you tilt the test tube, you'll get more DNA.
11. Pay attention to the characteristics of the DNA as it precipitates.



12. Pull out the DNA. Observe how the DNA looks and feels. Record your observations in the Post Lab Question #1.
13. Extension: To look at the DNA under a microscope, put the glob on a clean slide and gently stretch it apart using two toothpicks. The fibers will be easier to see in the stretched apart area.

Post Lab Questions:

1. What did the DNA look like? Be specific.
2. Explain how you were able to break down the cell walls within the strawberry?
3. Explain how you were able to break down the cell membrane and the phospholipid bi-layer.
4. Explain how the DNA became visible.
5. In order to study our genes, scientists must extract the DNA from human tissue. Would you expect the method of DNA extraction we used for the strawberry to be the same for human DNA? Why or why not?

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Teacher Notes

Time needed to complete the lab: This lab can be completed in one 45 minute class period or less, depending on depth of content covered.

Target grade level: This lab is appropriate for 7th through 12th grade life science and biology classes.

Objectives

Students will gain experience using appropriate scientific instrumentation, and procedures.

Students will apply process knowledge to interpret observations of DNA extraction.

Major Concepts: While this lab is not a high-level inquiry based lab, it can be used to enhance the understanding of DNA. The idea that DNA is the blue print for life and is found in all living things is an important over-arching concept. In addition, the idea that DNA is not observable without the aid of highly sensitive instrument can be dispelled.

DNA spooling fits nicely with DNA electrophoresis labs and can be completed during the electrophoresis process. To approach open ended inquiry, students may consider exploring DNA extraction using other organisms.

Typical Results

This DNA extraction activity results in a large quantity of white DNA.

Answers to Questions

Guiding Questions:

1. Where is DNA found? Be specific.

DNA is found within the nucleus of eukaryotes (with the exception of red blood cells), and found within the cytoplasm of prokaryotes. Students most likely will indicate that DNA is found in all living organisms within the cells and nucleus.

2. Is it possible to see and touch DNA? Explain your answer.

Answers will vary. This lab demonstrates that it is possible to see and touch DNA.

Post Lab Questions:

1. What did the DNA look like? Be specific.

Answers will vary. Most likely students will indicate DNA looks and feels like mucus or something slimy.

2. How did you break down the cell walls within the strawberry?

The cell walls were broken down by crushing the strawberry in the buffer solution.

3. Explain how you were able to break down the cell membrane and the phospho-lipid bilayer.

The detergent in the buffer solution helps to dissolve the phospho-lipid bilayers of the cell membrane and nuclear membrane, releasing the DNA from the nucleus.

4. Explain how the DNA became visible.

Ice cold ethanol causes the DNA to precipitate out of solution. DNA is not soluble in ethanol. The colder the ethanol, the less soluble the DNA will be in it yielding more visible "clumping".

5. In order to study our genes, scientists must extract the DNA from human tissue. Would you expect the method of DNA extraction we used for the strawberry to be the same for human DNA? Why or why not?

It's actually easier for animal cells. Animal cells do not have cell walls; therefore it wouldn't be necessary to filter out the cellulose debris. Also, animal cells can be lysed if they're put into a hypotonic solution.

All organisms contain DNA and the DNA found in all living things is similar in structure. While the order of nitrogenous bases varies creating the diversity of life, the structure for DNA, is the same across all Kingdoms of living things. DNA contains paired nitrogenous bases (adenine, thymine, cytosine, and guanine), and a backbone composed of alternating phosphate groups and ribose. DNA contains the blueprint for life and is found in every living thing on our planet earth.

Extension Activities

Students could extract DNA from a variety of sources and compare DNA results.

