Lab: DNA EXTRACTION

LESSON SUMMARY
In this lesson, students will remove DNA from plant cells (strawberries) and compare the process to DNA extraction in an actual biotech lab (will discuss in lecture). DNA is important because it is the chemical code that instructs each cell’s activity.

RELATED GAME CONCEPTS
DNA extraction, lysis solution, wash, elution buffer

NEW GENERATION FLORIDA STATE SCIENCE STANDARDS
- **SC.912.N.1.6**: Describe how scientific inferences are drawn from scientific observations and provide examples from the content being studied
- **SC.912.L.14.2**: Relate structure to function for the components of plant and animal cells. Explain the role of cell membranes as a highly selective barrier.
- **SC.912.L.14.3**: Compare and contrast the general structures of plant and animal cells.
- **SC.912.L.18.3**: Describe the structures of fatty acids, triglycerides, phospholipids, and steroids. Explain the functions of lipids in living organisms. Identify some reactions that fatty acids undergo. Relate the structure and function of cell membranes.

STUDENT LEARNING OBJECTIVES
- The student will be able to predict how the materials and steps of the experiment will help extract DNA.
- The student will be able to perform the DNA extraction following the correct procedure.
- The student will be able to observe and record what is happening at each step of the activity.
- The student will be able to identify what DNA looks like to the naked eye.
- The student will be able to summarize the experiment.
- The student will be able to compare and contrast the experiment to the events in Mission Biotech videogame.
- The student will be able to describe why scientists would need to extract DNA from cells of living things.

BACKGROUND INFORMATION
DNA can be found in the cells of every living, or once-living thing. It provides the instructions for building and operating all living things. The nucleus of a cell contains chromosomes.
Chromosomes are made up of DNA. DNA is short for deoxyribonucleic acid; it is a special chemical that carries the hereditary information in almost all living things. The DNA tells the cell how to work and which particular characteristics it should have. A section of DNA that tells the cell to display a certain characteristic, or produce a certain particular chemical is called a gene.

In the extraction experiment, the reagents used allow us to separate the DNA from the cell. First the physical mashing of the fruit breaks open the plant’s cell wall. The soap extraction solution ruptures the outer cell membrane, while the salt help separate the DNA from other cellular molecules, such as carbohydrates. The process of cooling helps protect the DNA from enzymes that normally do not bother the DNA because the DNA remains separated from the rest of the cell by the nuclear membrane. The cold temperature slows down these enzymes. Filtering removes most solid matter in the mixture. When the cold ethanol is added, it floats on top because of the difference in densities of the materials. DNA is not soluble in ethanol and precipitates out of the solution, visible as white strings.

**MATERIALS**

**For groups of 2 students:**
- 1 bag with a strawberry
- 1 large conical tube of extraction solution (solution A)
- 2 test tubes
- 1 plastic cup
- 1 funnel
- 1 piece of cheesecloth
- 1 pair of scissors
- 1 tube of ethanol (teacher should keep on cold until needed)
  Solution B
- 2 paper clips to make 2 hooks (optional)

**For groups of 4 students:**
- 1 bag with a strawberry
- 1 large conical tube of extraction solution (solution A)
- 4 test tubes
- 1 plastic cup
- 1 funnel
- 1 piece of cheesecloth
- 1 pair of scissors
- 1 tube of ethanol (teacher should keep on cold until needed)
  Solution B
- 4 paper clips to make 4 hooks (optional)
For each student:

- 1 copy of student procedure instructions
- 1 copy of student worksheet
- Images of solutions and equipment used in gaming environment to extract DNA

PROCEDURE

1. You are going to extract (or remove) DNA from strawberries today.
2. Today you will get the chance to see what the instruction manual actually looks like by removing it from the cells of a strawberry.
3. Read all instructions completely before beginning the activity.
4. Locate/ID all reagents and supplies to be used in the extraction experiment.
5. Fill out the prediction section of their worksheet individually.
6. Complete the lab (see student procedure handout) and fill out the questions/observations table in the experiment section of the worksheet.

**Fruit Extraction: Student Procedure**

1. Familiarize yourself with the components of the kit for your group (should contain all materials except the tube of Solution B). Remove the green leaves from the fruit. Discard the leaves.

2. Add 20ml Solution A to the bag containing the fruit. Close the bag, being careful to remove as much air as possible. Press the fruit and Solution A until very well mixed.

3. Strain the mixture using the funnel, cheesecloth, and cup. Allow to strain undisturbed for three to five minutes.

4. Each person should pour about 2.5cm (~one inch) of the filtered fruit mixture into a test tube.

5. Obtain tube of Solution B from teacher. Gently add Solution B to each test tube by slowly pouring ~2.5cm Solution B down the inner side of the test tube. Do not mix. Allow your tube to be still for three to five minutes.

6. White strands should form at the interface of the Solution B and filtered fruit mixture.

7. You can attempt to remove the strands with the paperclip by unfolding the paperclip to producing a hook. Scrape it off of the paperclip into one of the small flip-top tubes to save your result.

DNA EXTRACTION 3
8. **Clean up**: Rinse your test tubes well and return them to your station. Rinse the funnel and scissors and return them to your station. Place the clean test tubes, funnel, scissors, and the large Solution A tube back into the kit. The paperclips, paper towels, cheesecloth and contents, plastic cup, and Ziploc bag used to mix the fruit can be discarded. Bring your Solution B tube back to the front of the room.

**Introduction**

All living organisms contain an instruction manual within each of their cells. You are going to locate the strawberry’s instruction manual and remove it from the strawberry.

**Prediction**

1. What is the instruction manual and where is it found?

2. What do you think the instruction manual will look like when you remove it? Draw or describe it here.

**Experiment**

1. As you do the activity, fill out this table with questions that you have and observations that you make. Be as detailed as possible about what you observe at each step of the experiment.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Questions</th>
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Post questions:

1. Why did you need to mash the strawberry? What happened?

2. What characteristics did Solution A have?

3. Why might we add soap to the strawberry? What would that do to it?

4. What purpose is there for filtering the strawberry/Solution A mixture?

5. Tell me about Solution B. What observations did you make?

6. At the interface where the filtrate in the test tube and solution B meet, what happened?

7. What do you think this is?

8. Why would we want to extract DNA? Have you ever heard of scientists using DNA? What did they use it for?

9. Do you think the DNA extracted from a strawberry is pure enough to use in other biotechnology applications such as PCR or genetic engineering?

10. Summarize the experiment. Include what each material and step of the procedure did to help extract the DNA from the fruit.