DNA Extraction from Fruit

Lab Safety
Safety goggles should be worn during the lab.
Carefully pour all reagents during this lab.
Clean work area thoroughly after lab completion.
Return all materials to appropriate location as directed.

Overview
This ninety minute (two class periods of 45 minutes) lesson is designed to teach students in grades 5 through 9, how to use a simple protocol to extract DNA from eukaryotic plant cells. The students will also have the opportunity to see DNA without a microscope. Students will review the structure and function of DNA, basic cell structures, and discuss why scientists or other professionals might want to extract DNA from various sources. This lesson should be done after a lesson on the structure of DNA.

Learning Outcomes
Students will be able to:
- use a basic proctocol for extracting DNA from plant cells.
- explain the differences between plant and animal cells.
- use prior knowledge of cell structures to determine the most efficient method of DNA extraction from eukaryotic cells.
- describe the significance of understanding cell composition in a DNA extraction.
- examine real DNA without a microscope, and explain how it is possible.

Prerequisite Knowledge & Skills
Knowledge
Students should be able to:
- describe the plant cell, including structures such as the cell membrane, cell wall and nucleus.
- discuss the structure and function of the DNA molecule
- describe the relationship between chromosomes and DNA.

Skills
Students should be able to:
- read the temperature from a thermometer in degrees Celsius.
- use a transfer pipette.
- measure with a graduated cylinder.
- pour reagents.
- conduct careful observations.
- record, analyze, and report data from observations.

Misconceptions
Students might believe that they will be able to see the double helix without the help of a microscope.

Materials and Equipment
- Student lab note book
- 5 ml pureed fruit (baby food works well)
- Transfer pipettes-1 per student pair
- Water bath-1 per class
- Small racks or large cups to hold materials
- Clear plastic inoculating loops-1 per student pair
- Permanent markers-1 per student pair
- Paper coffee filters – 1 per student pair
- Disposable plastic cups – 1 per student pair
- Clean snap cap tubes – 1 per student pair
- Microscopes (optional) – 1 per lab table
- Photocopy the corresponding printable student worksheets
- List of reagents and recipes for this lab can be found in the **Teacher's Guide** on the Lab Center.

Lesson
Day 1
Pre-lab (45 minutes)
Teacher Prep
- Photocopy the "Background Reading" and "Plant and Animal Cell Comparison Chart" from the **Student Lab Notebook.**
- Read the background information and the teaching tips in the **Teacher's Guide**
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a) Before Class:
Students will receive "Background Reading" to read for homework the night before starting the lab and will write 2-3 questions they have after reading. Students will also highlight any unfamiliar terms and write the meaning of one of the terms that they have highlighted according to the context in which the word is used in the "Background Reading."

b) **During Class**:
Pair –Square (2 pairs) - Using the questions they developed from the homework assignment, each group will agree on one question that they find most interesting. Each group will record this question on a sentence strip to be collected by the teacher and posted in the classroom. The teacher will also post one or two of his/her own questions.

Mini-lesson
Review the cellular structures of plant and animal cells with the class. Hand out a copy of the "Plant and Animal Cell Comparison Chart" to each student. Demonstrate to the class how to use the comparison chart (copy the comparison chart

from the teacher's guide to a transparency and use the transparency to demonstrate to the class how to complete the transparency chart).

Day 2
Lab Activity (45 Minutes)
Teacher Prep

- Prepare mashed fruit as described in the **Teacher's Guide**
- Photocopy the "Cell Membrane" and "DNA Extraction from Plants" handouts from the **Student Lab Notebook.**
- Prepare the water bath. Temperature should be 60°C.
- Set up stations with appropriate material for each pair of students. This should include a rack, a permanent marker, soap buffer, ethanol, pureed fruit, a transfer pipette, a coffee filter, a plastic cup and a plastic rod.

Part 1

- Ask students how they might extract DNA from eukaryotic cells, such as plant cells. They should realize after reading the "Background Reading," observing diagrams and discussing cellular structures that the outer membrane and cell wall are not the only barriers between a plant cell's DNA and the outside environment. There is also a nuclear membrane that has to be penetrated.
- Point out that breaking through a membrane can be compared to breaking through a wall. If a builder needed to knock down a wall, how would he or she determine which tools might work best? What specifically would the builder need to know about the wall itself?
- Instruct students to examine the components of the cell membrane. Make sure that the students understand that lipids are fat molecules. If a membrane is made primarily of fat molecules, what kind of tool could be used to break it down, or dissolve it?
- Discuss the fact that household soaps/detergents are used all the time to dissolve fat from greasy dishes, skin and laundry. In this experiment, dishwashing detergent dissolves the eukaryotic cell membrane and nuclear membrane in the same way, thus releasing DNA from the cell. In addition to membranes, there is also a cell wall made of cellulose. Mechanically pulverizing the fruit should destroy the wall.

Part 2

- Ask a student to read steps 1-4 of the procedure aloud and demonstrate each step then give students the opportunity to begin their experiments in small groups.
- During the 5-minute incubation, discuss what is happening inside all of the tubes, and what will need to be done next with the class. Once the DNA is released from the cells, it needs to be precipitated (separated from the solution) from the soapy solution in which it lies.
- Demonstrate how to use a coffee filter to separate the fruit pulp in the tube from the liquid cell contents. Collect the liquid in a clean cup and transfer it to an empty snap-cap tube.
- Have another student read step 5 from the procedure, while the rest of the class listens. Instruct students to draw a diagram of what will happen the precipitation with ethanol is completed in step 5. Make sure students understand that ethanol is a type of alcohol, similar to rubbing alcohol. Because of its chemical properties, DNA is not soluble in ethanol, and it can therefore be used to separate the DNA from the soapy solution in the tube.
- Demonstrate how to use the transfer pipette to add ethanol. Slowly pour ethanol down the side of a slanted bacteria tube and emphasize the importance of holding the tube on an angle.
- Show students how to spool the DNA from the ethanol layer with a plastic rod without breaking through the soap layer. It is essential that the two layers remain separated.
- If students would like to keep their DNA samples, they can be stored in small tubes of ethanol.

Post Lab
Analysis & Discussion

- Ask students how it was possible to see real DNA without the help of a microscope
- Discuss how James Watson and Francis Crick were able to determine the shape of the DNA molecule.
- Discuss the fact that the DNA extraction is an experiment that is not only used by scientists, but also by detectives (fingerprinting) and doctors (disease diagnosis). Why would someone want to extract *plant* DNA?

Optional (or this could be discussed or demonstrated)

- Students are always curious to see if the double helix will be visible when magnified. If compound microscopes are available, spread some DNA on a slide, and stain with methylene blue. Even when magnified 400-1000X, the double helix will still not be visible, but students enjoy figuring this out on their own!

Students will discuss the following questions in groups and then each student will write each question and their individual answers to the questions in their **lab note books**.

1. Why was it important to shake and mix the tube with the bacteria cells and soap solution?
2. Explain the importance of placing the tube with the soap solution and pureed fruit in the hot water bath for 5-15 minutes.
3. Describe what happened after the ethanol was added to the soap solution.

Applications

Instruct students to work with a partner. Each Group of 4 students (at each lab table) will select a reporter for each lab table. Have students read the questions on their own, discuss the question with a partner then write their response to the question in their lab note book.

1. How do scientists create genetically modified fruits?
2. How can you find out if the fruits in your salad had a change in their DNA?

Use a different protocol to extract DNA from fruit. Compare and contrast the results.

Further Exploration

Students could be assigned (grouped or work individually on) any of the following *extended and enrichment tasks*.

Write a one (1) page essay about the ethical, legal, and social implications or issues of recombining DNA into plants.

Students can research a variety of plant species to determine the chromosome number in each and create a **comic book**. In the comic book include the answer to this question, "If an organism has more chromosomes, does that mean that it is more complex? What portion of one organism's genes are the same as another's?"

Vocabulary

For **homework** instruct students to use the following vocabulary words to create a song, poem or a concept map entitled "DNA Extraction from Fruits." Use the following words: Plant cells, extraction, cell membrane, cell wall, nuclear membrane, nucleus, eukaryotic cells, , DNA (Deoxyribonucleic Acid) soap solution, water bath, ethanol

Vocabulary (see glossary for definition)

Deoxyribonucleic Acid (DNA)
Chromosome
Eukaryotic
Prokaryotic
Plant cell
Cell membrane
Cell wall
Molecules
Incubation
Nucleus

Resources

Web Sites:
http://www.bacteriamuseum.org/main1.shtml
The Virtual Museum of Bacteria

http://www.dnaftb.org
A website of the Dolan DNA Learning Center

http://www.dnai.org
A website of the Dolan DNA Learning Center

http://www.ygyh.org
A website of the Dolan DNA Learning Center

Books:

Balkwill, F. (2002). *Enjoy your cells*. MN: Carolrhoda Books, Inc.

Balkwill, F. (1990). *Cells are us*. MN: Carolrhoda Books, Inc.

Balkwill, F. (2002). *Have a nice DNA.* MN: Carolrhoda Books, Inc.

Hoagland, M., & Dodson, B. (1995). *The way life works*. MN: Carolrhoda Books, Inc.

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