Lesson Title: DNA Extraction

Subject	Grade Level	Timeline
Life Science	6 - 10	45 - 60 minutes

Objectives

In this lesson students will be able to see what DNA looks like at the macroscopic and microscopic scale. Students will learn the simple tools and method for extracting DNA from plant cells, and why each step is performed. Students will learn why scientist extract DNA from cells.

Standards

Next Generation Science Standards
Middle School Life Sciences Storyline
https://www.nextgenscience.org/sites/default/files/MS%20LS%20DCI%20Storyline%204%209%2013.pdf
High School Life Sciences Storyline
https://www.nextgenscience.org/sites/default/files/HS%20LS%20DCI%20combined%206.13.13.pdf

Students who demonstrate understanding can:

MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and the ways parts of cells contribute to the function.
HS-LS3-1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Materials

- Dried peas (or other plant items - see Teacher Background in the Lesson Plan section)
- Rubbing alcohol (93% isopropyl or ethyl alcohol - for best results, chill in a freezer before)
- Measuring cups and measuring spoons
- Containers (beakers or cups to hold approximately 16 oz, 500mL, or more)
- Cold water
- Table salt
- Meat tenderizer
- Blender

- Dish soap
- Filter paper or coffee filters

Vocabulary

Precipitate - To cause a substance to be deposited in solid form.

DNA - deoxyribonucleic acid is the hereditary material in almost all organisms, and is found in the nucleus of the cell.

Lysis - The disintegration of a cell by rupture of the cell wall.

Lesson Plan

Background for teachers:

DNA must be removed from cells in order to perform DNA sequencing, which is the process scientists use to determine the exact order of nucleotides in a DNA chain. The sequence is a code that scientists are studying to understand the genetic information that is carried in the DNA molecule.

Substitutions:
In the STEM-in-30 video, astronaut Kate Rubins extracts DNA from dried peas. This same basic process can be performed on other plant matter, such as ripe strawberries or spinach, or on animal matter (e.g. chicken liver). The procedure below is written for dried peas but is basically the same in all cases. If using fresh fruit, the initial step of mixing with cold water can be omitted - but don't omit the salt!

In place of using a blender it is possible to have students place the fruit in a sealable bag and (once sealed) pulverize the fruit by hand, pressing the bag between thumb and palm, but not pounding on the bag (which is likely to cause the bag to tear and the fruit juices to leak!)

If you cannot find meat tenderizer, pineapple juice can be substituted. Or contact lens cleaning solution!

Safety: Students should be reminded that plant and animal matter that would be considered food in the kitchen is not safe to eat in the science classroom.

Student Activity:

1. If using a dry food (for example, split peas), first mix the peas with cold water according to the following ratio:

- ½ cup of split peas (100 mL)
- 1 cup cold water (200 mL)
- ⅛ teaspoon table salt (~1 mL)

2. Blend on high for about 15 seconds. This separates the cells from one another, spreading them out through the water you have added (or that was already present).

3. Gently pour the soupy mixture through a filter or a fine mesh strainer and into another container. This can be done with filter paper or with coffee filters. Take care not to rip the filter! The filter and its contents can be thrown away.

4. Mix the fluid that came through the filter with 2 teaspoons (30 mL) of dish detergent and allow to sit for 5-10 minutes.
    - Each cell is held together by its cell membrane. The DNA is inside the nucleus, which is inside the membrane. The detergent will separate the parts of the cell membrane - the lipids from the proteins. It will also open the sphere of the nucleus, leaving the DNA free to move throughout the solution

5. Add meat tenderizer and gently stir by hand. Meat tenderizer acts as an enzyme to remove the proteins that surround the DNA and hold it in place.

6. Slowly pour in isopropyl alcohol (about as much alcohol as you have filtered, soapy split-pea solution) and observe as the rubbing alcohol causes the DNA cluster to separate from the solution and precipitate out from the rest of the solution. It forms a whitish, slime-looking clump that is less dense than the solution and will therefore float on top.

7. The DNA can be removed from the solution with a stirring rod. At this point, scientists would place the DNA in a centrifuge or other equipment for their experiment.

Extensions

- It is possible to collect the DNA and put it on a microscope slide. Use toothpicks or dissecting pins to gently stretch out the glob.
    - It may be interesting to see what the DNA looks like at the microscopic level, but the famous twisting double helix shape is actually smaller than light waves, and impossible to see with a microscope that uses light.

- Research how the shape of DNA was discovered if it is too small to see, even with a microscope!

- The experiment can be repeated with a different material to compare how much DNA is produced (e.g. split peas vs strawberries or bananas or spinach)

Resources

University of Utah: http://learn.genetics.utah.edu/content/labs/extraction/howto/

National Human Genome Research Institute at NIH:

- https://www.genome.gov/
- https://www.genome.gov/education/