**Extraction of DNA from Fruits and Vegetables**

**Using Household Chemicals**

**Focus Question:** How is DNA extracted from cells?

**Learning Objectives:** Students will understand the steps required to extract DNA from plant cells.

**Teaching Time:** 45 minutes for the activity

**Preparation Time: 30-40 minutes**

**Note to the Teacher**

This protocol uses mechanical disruption and common household chemicals to extract DNA from fruits and vegetables. Students will be able to see DNA as a stringy mass. The procedure yields fair to large amounts of DNA, depending on the fruit or vegetable and the type of alcohol used in the final precipitation step. While the DNA isolated in this experiment is too impure to use in gel electrophoresis or restriction analysis experiments, it is an excellent hands-on lab suitable for large numbers of students, multiple class sections, and restricted budgets. This is an excellent lab for general biology and advanced biology classes, in units covering cell biology, genetics, or biotechnology. Review the structure of DNA and cellular features such as membranes, organelles, and cell wall structure with students before beginning the lab.

Onion and tomato work well, but students can experiment with other fruits and vegetables. Some fruits and vegetables contain polysaccarides which make purification of the DNA more challenging. This procedure is similar to what scientists would use in the lab to purify DNA from any organism. Scientists would include additional purification steps to remove contaminating RNA and proteins.

This protocol is based on one described by Shawn Carlson in *Scientific American* (September 1998, 96-97). We have scaled up the protocol to serve an entire class.

**Materials**

Student Activity Worksheet

1 large onion or tomato

blender

wooden applicator sticks (thin, about the size of coffee stirrers)

large beaker to hold filtrate

small graduated cylinders or plastic 15 ml tubes with mls indicated to measure 10 ml

1 ml transfer pipettes

50 ml beakers (1 per student or pair)

cheesecloth, cut and folded in several layers to cover the large beaker generously

empty film canisters (1 per student or pair) (becoming antique in the digital era)

**Solutions**

**Alcohol**: Ice cold ethanol (hint: Pre-measure 20ml ethanol into film canisters and place in the freezer until ready to use. Each student or group will receive one canister of alcohol. Isopropanol (99%; do not use rubbing alcohol which is usually 70%) may be substituted for ethanol.

**Lysis Buffer** (chilled)

1 liter distilled water

12.5 g table salt

42 g baking soda

**Detergent Solution**

Prepare a 50% solution of liquid laundry detergent in water.

25 ml Tide + 25 ml water. Mix well. Store at room temperature.

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Period:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**DNA Isolation from Fruits and Vegetables**

**Student Worksheet**

**Background**

DNA is the genetic material of all organisms. Extraction and purification of DNA is the first step in many molecular biology experiments. Whether a scientist is interested in studying an organism’s entire genome or cloning a gene from that organism, the extraction of DNA involves the same three steps:

1. **Cell Lysis**Cells are broken open or lysed, using mechanical and chemical means. The cell wall (if present), cell membrane, and nuclear membrane (if present) must all be disrupted to release the DNA. Cell membranes are composed of fats and proteins which can be dissolved with detergent (in this experiment laundry detergent). Plant cells, yeast, and many bacterial cells are surrounded by a cell wall which can be disrupted with mechanical force such as blending or grinding, or with enzymatic digestion. Nuclear membranes are found in eukaryotes.
2. **Purification**Once cells are broken open, the entire cellular contents are mixed together. Most manipulations of DNA require the DNA to be free of proteins and RNA. In the lab, scientists would take care to inactivate cellular enzymes which degrade or breakdown DNA. They might use protein-digesting enzymes, heat, certain chemicals, and organic solvents such as phenol to inactivate enzymes and remove proteins from nucleic acids. In this lab, we will not be purifying the DNA because we will not use the DNA for further experiments.
3. **Precipitation and Concentration**DNA is soluble in water and insoluble in alcohol. To visualize the DNA, add ethanol to the cell lysate. The DNA will form a stringy mass at the interface of the alcohol and aqueous layers. In the lab, a scientist would collect this DNA mass by centrifugation. The DNA pellet can be resuspended at a high concentration in a new soultion for the next manipulation. DNA is an extremely stable molecule and can be stored for years.

**Procedure:**

1. As a class, prepare a vegetable or fruit filtrate. Peel 1 onion and cut into large chunks. Place in blender. Add 250 ml of lysis buffer. Alternatively, quarter 1 tomato and add 250 ml lysis buffer.
2. Homogenize the onion and solution for 8-10 seconds (4-5 seconds for tomato) on high. Blend until there are no large chunks left. Do not over homogenize, as this will shear the DNA too much and it won’t spool well. Every blender is different, so you may have to adjust the blending time.
3. Slowly pour the homogenate through the cheesecloth into a large beaker. This liquid is now the filtrate. Dispose of the cheesecloth in the garbage.
4. Each student should measure 10 ml of the filtrate and pour the filtrate into a 50 ml glass beaker.
5. Add 1 ml of the detergent solution. Stir to mix well with a wooden applicator stick. The detergent will destroy the cell membranes and denature the proteins.
6. Pour 20 ml of ice-cold ethanol down the side of the beaker. The alcohol should form a layer on top of the aqueous phase. If ethanol is not available, use 10 ml (yes 10 ml not 20 ml) of ice-cold isopropanol.
7. Let the alcohol sit for 2-3 minutes without disturbing the beaker. Bubbles will form, and the DNA will precipitate as long, stringy fibers out of solution.
8. Gently spool the DNA on a wooden applicator stick.

**Questions**

1. Draw a diagram of an onion cell and its cellular compartments. Where is the genomic DNA located in an onion cell? What other cellular compartments contain DNA?
2. Describe the structure of DNA. How is genetic information stored within this structure?
3. Why did you blend the onion?
4. What function does the detergent have in the experiment? The alcohol?
5. What is the process of breaking open a cell called?
6. Why does the alcohol form a layer on top of the cell lysate?
7. Is the DNA you spooled pure? Why not?