DNA, A Biological Polymer

Objective:

Students will:

Experience how to isolate DNA from strawberries using simple household ingredients.

Introduction:

DNA, or deoxyribonucleic acid, is a biological polymer composed of millions of copies of 4 chemical building blocks called Nucleotides arranged in unique order. DNA molecules encode the hereditary material in all organisms including humans. DNA is present in all cells as a double helix. What makes plants and animals different is how these four nucleotides in DNA are arranged. It is their sequence which determines which proteins are made, and the information they encode decides the fate of the organism whether to produce scales or leaves; legs or a stalk.

To obtain a DNA from a cell, scientists typically rely on one of many DNA extraction kits available from biotechnology companies. For DNA extraction, detergent is used to lyse (to break open) the cell so that DNA can be released into the solution. Then alcohol is added to cause the DNA to precipitate out. Strawberries are chosen for this particular experiment because a strawberry cell has eight copies of the genome, and it would be easier to extract the DNA since it is a lot per cell whereas most of the organisms would only have one genome copy per cell, (1).

Figure 1. While other fruits are soft and just as easy to pulverize, strawberries are the perfect choice for a DNA extraction because strawberries yield way more DNA than other fruits. This is because strawberries are octoploid, meaning that they have eight copies of each type of DNA chromosome. (Human cells are generally diploid, meaning two sets of chromosomes.) These special circumstances make strawberry DNA both easy to extract and to see, (2).

Materials:

- Rubbing alcohol.
- Measuring cup.
- Measuring spoons.
- Salt.
- Water.
- Dish washing liquid (type used for hand washing dishes.
- Small glass bowl (or 250 mL glass beaker).
- Small kitchen strainer
- Medium drinking glass (a second 250 mL glass beaker).
- Small drinking glass (or 100 mL glass beaker).
- Three strawberries.
- Resealable plastic sandwich bag.
- Small glass jar.
- Plastic tweezers.

Procedure:

- Chill about 1 cup of rubbing alcohol in the freezer.
- Mix one half teaspoon of salt, one third cup of water and one tablespoon of dish washing liquid in a glass or small bowl. Set the mixture aside. (This is your extraction liquid)

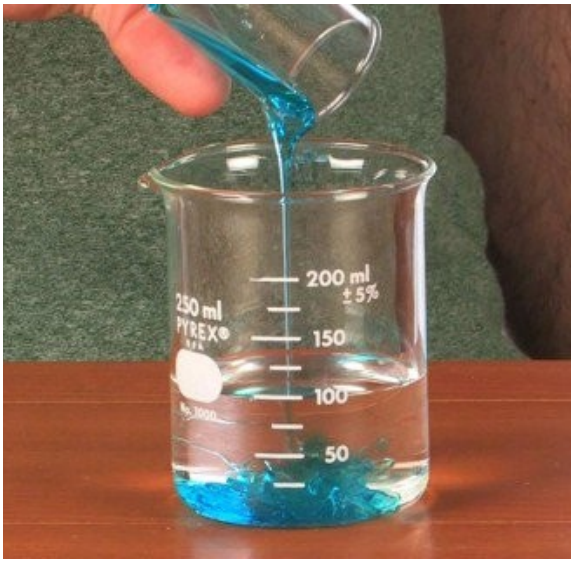

Figure 2. Making the extraction liquid. Adding 2 tsp (10mL) of dish washing soap to 6T (90 ml) of salt water into a small glass container.

- Remove and discard the green tops from strawberries.
- Put the strawberries into a resealable plastic sandwich bag and push out all the extra air. Seal the bag tightly.
- With your fingers, squeeze and smash the strawberries for two minutes.
- Add three tablespoons of the extraction liquid you prepared to the strawberries in the

bag. Push out all the extra air and reseal the bag.

- Squeeze the strawberry mixture with your fingers for one minute.
- Pour the strawberry mixture from the bag into the kitchen strainer resting on the medium size glass.
- Let the liquid it drip through the kitchen strainer. Use a spoon to press the mashed bits of strawberry against the strainer forcing even more of the mixture into the container.

Figure 3. Pouring the mashed strawberry pulp and extraction mixture through a strainer and into a medium drinking glass or similar container.

- Pour the filtered strawberry liquid from the medium size glass into the small glass jar so that the jar is one quarter full.
- Measure out one half cup of cold rubbing alcohol.
- Tilt the small jar and very slowly pour the alcohol down its side.
- Pour until the alcohol has formed approximately a one-inch-deep layer on top of the strawberry liquid. You may not need all of the one half cup of alcohol to form the one-inch layer.
- Do not let the strawberry liquid and alcohol mix.

- Study the mixture inside of the jar. The strawberry DNA will appear as gooey clear/white stringy stuff
- Dip the tweezers into the jar where the strawberry liquid and alcohol layers meet and remove the DNA from the solution.
- Lay the DNA on a dish to examine it.

Figure 4. One tsp (5 mL) of the chilled isopropyl alcohol rests on top of the extraction solution. The DNA gathers at the interface of the two liquids as a white mass that can be removed with tweezers.

Discussion:

When the salt and detergent mixture was added to the smashed strawberries, the detergent helped lyse the strawberry cells, releasing the DNA into solution. The salt helped create an environment where the different DNA strands could clump together making it easier to see them. Most of the bubbles in the extraction bag is because of the detergent.

After added the cold rubbing alcohol to the filtered strawberry liquid, the alcohol should have precipitated the DNA out of the liquid while the rest of the strawberry liquid remained in the detergent solution. You should have seen the white/clear gooey DNA strands in the alcohol layer as well as between the two layers. A single strand of DNA is extremely tiny, too tiny to see with the naked eye, but because the DNA clumped in this activity you were able to see just how much of it three strawberries have when all of their octoploid cells are combined! Octoploid means each cell has eight copies of the genome.

References:

1) Squishy Science: Extract DNA from smashed strawberries. A genetically geared activity from Science buddies. Web site active August 2017, https://www.scientificamerican.com/article/squishy-science-extract-dna-from-smashed-strawberries/

2) Strawberry DNA – Food Science Steve Spangler, Website active August 2017, https://www.stevespanglerscience.com/lab/experiments/strawberry-dna/

Name _____ Date _____

Lab Questions:

1. Why did we use strawberries in this experiment; use the words squishy fruits and octoploidal and explain its meaning.

2. What was the purpose of the detergent; use the word lyse and explain its meaning.

3. What did the NaCl salt do in this experiment?

4. Why do you think that the DNA was extracted using alcohol?

5. What do you think would have happened if we had used warm or hot alcohol.

6. What did the DNA look like?

7. How small is the DNA and why can we see it now?

8. If we had used 9 strawberries instead of 3, do you think we would have: _____
   a) the same, b) twice as much, c) three times as much, d) five times as much