MB003

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# Show Me My DNA: Engaging Florida Elementary Students in Biotechnology[1]

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Recent studies have found that United States dominance in science and engineering may be slipping, because America's share of graduates in these fields is declining in comparison to graduates in Europe and developing nations (Freeman, 2006). Many factors underlie this erosion in our scientific preeminence. A recent survey of Florida high school and middle school students found that more than half were not aware of basic concepts in genetics and biotechnology, but greater than half of students surveyed expressed a desire to learn more (Drew et al., 2006). This study found that interest in learning about genetics and biotechnology declined between the middle school and high school years, indicating that the window of opportunity for sparking students' interest in science begins to close at an early age (Drew et al., 2006). A crucial key to the reversal of this disturbing trend relies on the early engagement of elementary schoolchildren in the wonder of science.

When asked to name the single moment when they were hooked by science, many modern molecular biologists immediately describe the first time they isolated the genetic material, DNA, from cells. They often describe their awe at witnessing the long ropy strings of DNA precipitating in a test-tube. This single lab moment seems to be the first time students realize that the blueprint of life is not just an abstract double-helical squiggle on the blackboard, but a real chemical compound which they can manipulate with their own hands and minds. This eye-opening moment can be a springboard to further exploration of the biological world.

Isolation of DNA has been incorporated in pre-college educational science programs for a long time, and a number of kits providing the materials to conduct this exercise in the classroom are commercially available. However, middle to high school students are typically the target group for this activity. Bringing a DNA isolation laboratory exercise to elementary school classrooms requires special considerations, such as safety, difficulty, cost, duration, and the age of the particular group of students.

The following classroom laboratory exercise was designed to be completed within one hour by an

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average-sized elementary school classroom (20-25 students). It was developed as part of a hands-on Career Day presentation at Robert Louis Stevenson Elementary School, a Brevard County public school. The attending students and their teacher first listened to a brief introduction consisting of:

- an explanation of the DNA molecule as the blueprint for life;
- an explanation of genetic engineering and its benefits; and
- a flow chart of the DNA extraction procedure.

The students then proceeded to extract DNA from their own cheek (buccal) cells. The point was made that the procedure is basically the same technique used by scientists to extract DNA for:

1. Genetic engineering,

2. Detection of genetic diseases, and

3. Forensic analysis.

## Materials and Methods

All procedures to extract DNA from cells share key steps that include the following:

1. lysing, or breaking open, the cells with detergent to release the cell contents;

2. separating proteins and other cellular components from the DNA with enzymes that digest proteins; and

3. precipitating the DNA strands out of solution with salt and alcohol.

**Each student was provided with the following materials**:

One disposable 3-oz paper/plastic cup containing 7 milliliters (ml) of Gatorade® (must be clear with no colored dye)

One 15-ml conical-bottom screw-cap disposable polypropylene centrifuge tube with graduations [Fisher Scientific S50712]. The 5 ml line was made more apparent with a black marker

**Materials the instructor needs:**

2 micropipettors with disposable tips, one capable of measuring 10 microliters (µl) and the other 250 µl.

2 disposable 10-ml pipets

Pipet bulb for 10-ml pipet

Water Bath with thermometer, set at 55°C (130°F)

Test tube rack in the water bath

Permanent markers

10% SDS (detergent) solution (prepare the solution for the class by dissolving 10 g sodium dodecyl sulfate in a final concentration of 100 ml water)

5 Molar (M) NaCl salt solution (prepare the solution for the class by dissolving 29 g NaCl in a final concentration of 100 ml water)

Protease K (optional)

Isopropanol (must be pure; 70% rubbing alcohol does not work)

**Note**: Hot tap water in a container could be used instead of a water bath. Before using this alternative, verify that the water supply temperature is 55°C (130°F).

**Procedure**

1. Each student collects his/her cheek cells by swishing the Gatorade® in his/her mouth and spitting back into the cup. For best yield, vigorous swishing accompanied with gentle “scraping” of the interior cheeks with the molars (no blood!) was encouraged. Repeat swishing of the same sample 2-3 times.

2. Student writes his/her name on the conical centrifuge tube provided. Pour the obtained sample into the tube up to the marked 5-ml line. Discard the rest.

3. To each student's tube, the instructor adds:

250 µl of 10% SDS

2 ml of 5M NaCl

10 µl of Protease K (optional)

4. The student caps the tube, and mixes the contents by gently inverting the tube several times.

5. All tubes are placed in a water bath at 55°C for 15 min.

6. The instructor slowly layers 4 ml of isopropanol into each tube and caps the tubes tightly.

7. After a 5 min wait, each student inverts his/her tube several times and observes the white material, their DNA, appear.

## Results

Students showed a remarkable degree of excitement. Just as importantly, their teacher participated and expressed that she had learned from the exercise. Many questions were asked, often revealing several common misconceptions about DNA and biotechnology. These served as excellent springboards for discussion. The visible reactions of children, as well as their subsequent thank-you notes, indicated that seeing their own DNA, and taking the tube containing it back home, made the biggest and most lasting impressions.

## Conclusions

The above exercise demonstrates that the extraction of DNA in an elementary school classroom is a feasible and enjoyable introduction to genetics and biotechnology principles. The experiment offers elementary school teachers and students the chance to see that biotechnology is approachable by anyone. It is our hope that this experience generates excitement and curiosity about biotechnology, encouraging students to learn more about this field that is increasingly affecting our lives, or even to consider entering a scientific career.

To do this activity in a classroom or other adult-supervised setting, the materials can be obtained from Fisher Scientific (https://www1.fishersci.com) or Sigma-Aldrich Chemicals (http://www.sigmaaldrich.com). As the supplies are commonly used in laboratories, local high schools, community colleges, or university science departments are excellent resources and likely to have access to the materials. Additionally, kits for DNA isolation can be ordered for a fee from BioRad (www.explorer.bio-rad.com) and Edvotek (www.edvotek.com).

## References

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