

Lesson Plan: Extracting DNA from Strawberries

This is a module-based project

Teaching Plan:

This project is designed for a shorter mentoring period to either allow time for other activities or for more explanation and/or demonstration. First, the mentors will explain the basic concept of DNA and its role in all living things. Next, mentors will explain how DNA is composed of deoxyribose, phosphate and nitrogen bases, and how there are four unique nitrogen bases: adenine, guanine, cytosine, and thymine. (Uracil can be introduced if desired).

Other topics that can be covered can include DNA mutation, the human genome, what makes humans different from one another, etc., but these topics may be too in-depth to be useful.

Agenda:

- 1) Explanation/Discussion ~10 min
- 2) Activity ~15 min
- 3) Reflection/Worksheet ~10 min

Total: 35 min.

Goals of each activity:

- 1) Explanation/Discussion – To introduce fundamental concepts in genetics and familiarize mentees with molecular biology.
- 2) Activity – To physically visualize DNA and to show students how DNA can be found in all living things.
- 3) Reflection/Worksheet – To reinforce concepts and to allow students to leave class feeling excited about learning new scientific ideas.

The nature of molecular biology demands slightly more explanation prior to the activity than other lessons, such as heat transfer or chemistry, simply because not many mentees will have had the opportunity to work with or think about DNA before. The initial explanation section of the lesson will appeal to reflective and intuitive students, but admittedly might be less interesting to active and sensing students. To remedy this, a model should be brought into class, with the pre-made DNA provided and shown as an example. Also, a video can be brought in as well if helpful. Sensing students will also benefit from the models brought into class.

The explanatory sections will appeal better to verbal input students, whereas the activity will be interesting to visual input students. It is best to put equal emphasis on both. For the most part, this project will be focused on global understanding; showing how DNA fits into the life process and how DNA is an integral part of every living thing, including humans.

Mentors Scientific Background

DNA is the fundamental molecule that codes life for all living organisms. It is an organic molecule composed of nucleotides, which are often referred to as base pairs. Each nucleotide is composed of three units: a sugar (deoxyribose), a phosphate group, and a nitrogen base. There are four nitrogen bases, adenine, guanine, cytosine, and thymine, with a fifth base replacing thymine in RNA known as uracil. Together, these bases are enough to code for the diversity of life seen in the biosphere.

DNA works through a mechanism commonly referred to as the dogma of molecular biology. DNA is transcribed into RNA, which is sent into the cell's cytoplasm for translation at a ribosome, a protein that is able to "read" the RNA. The RNA stores information in the form of codons, which are sequences of three base pairs that code for specific amino acids. As the ribosome reads along the RNA, the codons are translated into specific amino acids, which are joined continuously to form proteins. Essentially, unique DNA sequences, or genes, form the fundamental basis for diversity on earth and cells, with different functionalities within individual species and organisms.

This exercise allows mentees to extract and precipitate DNA from strawberry samples, creating strands of DNA that can then be isolated from solution. The key concepts to understand here are that of cellular structure and solubility.

After breaking up the strawberry mechanically using a plastic bag, add dish detergent. The non-polar attractions between the lipids in the detergent and the bi-lipid cellular membrane will break up the cells and release the contents into the solution. Salt will unravel the DNA from the proteins chains that keep the DNA strands together.

Note: Strawberries are preferred for this lab because they are octo-ploidy, meaning there are 8 copies of each chromosome in the genome. This large amount of nuclear material makes it easier to precipitate DNA out of the solution.

Finally, adding the ethanol precipitates the DNA out of solution because DNA is not as soluble in ethanol as it is in water. The ethanol disrupts the bonding forces between DNA and water, which allows the DNA to precipitate out of solution in the form of fine spindles. Note that using cold ethanol is advised, because DNA is soluble in ethanol to a certain extent. Cold ethanol has even less dissolving power than room-temperature ethanol.

Introduction for the Mentees.

After explanation the concept of DNA and how it works, images of DNA can be brought in on a powerpoint presentation. Also, including the image of DNA taken by Rosalyn Franklin will be helpful, because it will show the mentees historically how scientists conceptualized DNA and how it was first imaged.

The important concepts for mentees to take away are:

- 1) DNA and its functions
- 2) DNA's structure (in a general sense)
- 3) Chemical components of DNA (e.g. is DNA an acid or a base?)
- 4) The purpose of isolating DNA from organisms for scientists
- 5) DNA is present in food, animals, and all living organisms, including bacteria.

Modules/Demos, or Project

- 1) Precipitation of DNA from strawberries.

Other activities will be introduced for future sessions. However, given the time constraints of this final mentoring session, there will not be enough time for more than one activity.

Closing Activity and Discussion.

The closing activity should reflect the questions asked in the worksheet, namely what the students learned about DNA's function and structure. Also, the DNA extraction process can also be reviewed, with mentors going over each individual step and how it is crucial to the extraction process. A global understanding explanation should be given as to how extraction is a commonly used scientific technique and how it has led to deeper conceptualization of molecular biology.

The mentors, especially any bioengineers, can take some time to explain the work that they are doing in labs, or classes. It is prudent for mentors to familiarize themselves with recent developments in science, such as the advent of stem cells, cloning, pharmacogenomics, personalized medicine, etc. This will allow mentees to see how there is an entire industry centered on molecular biology and its applications.

Time should be left for questions. The discussion between mentors and mentees will be very useful to enforcing learned concepts for the mentees.

Worksheet

1. One of the key areas of understanding in this lesson is how each step is used in the DNA extraction process. Please match the procedure with its function:

PROCEDURE_FUNCTION

- A. Filter strawberry slurry through cheesecloth ____ To precipitate DNA from solution
- B. Mash strawberry with salty/soapy solution ____ Separate components of the cell
- C. Initial smashing and grinding of strawberry ____ Break open the cells
- D. Addition of ethanol to filtered extract ____ Break up proteins and cell membranes

2. What did the DNA look like? Relate what you know about the chemical structure of DNA to what you observed today.

3. Explain what happened in the final step when you added ethanol to your strawberry extract.

(Hint: DNA is soluble in water, but not in ethanol)

4. A person cannot see a single cotton thread 100 feet away, but if you wound thousands of threads together into a rope, it would be visible much further away. Is this statement analogous to our DNA extraction? Explain.

5. Why is it important for scientists to be able to remove DNA from an organism? List two reasons.

6. Is there DNA in your food? _____ How do you know?

Materials

- 5 strawberries (1 per group)
- water
- 5 tablespoons detergent (1 per group)
- 5 teaspoons table salt (1 per group)
- 100 mL rubbing alcohol (20 per group)
- 5 plastic cups (1 per group)
- 5 plastic spoons (1 per group)
- measuring cup
- 5 coffee filters (1 per group)
- 5 plastic ziplock bags (1 per group)
- 5 large paper clips (1 per group)

All materials can be found in your local Safeway.

References/Citations

“Strawberry DNA Extraction Lesson Plan.” Retrieved 26 Nov 2010.
http://gemsclub.org/yahoo_site_admin/assets/docs/StrawberryDNAExtra.4395135.pdf

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