Rationale
The ability to extract and isolate DNA from cells and tissues has allowed for huge advances in biotechnology, including the ability to identify crime suspects and the ability to sequence the entire human genome. With a small sample of DNA, you can test a newborn for many genetic diseases, analyze forensic evidence, or study genes involved in cancer. DNA extraction is also used in paternity cases.

Objectives
Student will:
- Isolate DNA from various types of cells.
- Understand the roll of each step in the process of DNA extraction.

Engage
- Students view applications of DNA Extraction.
  - King Tut Unwrapped
  - The story of Otzi the Iceman
- Discussion Questions:
  - Ask students why else would a technician want to sample and analyze DNA?
  - Where is DNA found?
  - What is DNA?
  - How does a technician isolate DNA?

Key Points
- Refer to the following sites:
  - How to extract DNA from anything
  - FAQ about Extraction: Troubleshooting

Activity
1. Students complete Pre-Lab: DNA Extraction on their own before coming to class to perform the lab exercise, or they complete it as a class.
2. Students perform Lab: DNA Extraction of Wheat Germ. This lab is straight forward and always yields visible DNA. In future labs, students will be extracting DNA from other sources, including cheek cells, so this is a good introduction to the basic methods used.
4. See Experiment Tricks of the Trade at end of lesson for further information.
Assessment

- Pre-Lab: DNA Extraction handout
- Lab: DNA Extraction of Wheat Germ
- Post-Lab: DNA Extraction
- Successful Isolation of DNA

Materials

- Pre-Lab, Lab, and Post Lab handouts for DNA Extraction.
- For wet lab:
  - 250 ml beaker
  - hot plate
  - Adolph's natural meat tenderizer
  - non-roasted wheat germ
  - ice cold 95% ethanol
  - thermometer
  - 15 ml test tube
  - glass stirring rod
  - Palmolive detergent
  - distilled water
  - test tube rack or 250 ml beaker
  - graduated cylinders (10ml and 100ml)

Accommodations for Learning Difference

- Visit the Special Populations section of the CTE Career and Technical Education Website: http://cte.unt.edu/special-pops

National and State Education Standards

Science Standards
Texas College and Career Readiness Standards
I. C1, C2, C3, D1, D2, D3, E2,
III. B2
Pre-Lab: DNA Extraction

Go to http://learn.genetics.utah.edu/content/labs/extraction/ and complete the virtual DNA Extraction Lab. Answer the questions below.

1. Why would a scientist need to extract DNA from a cell? List 3 reasons:

2. Where is DNA found?

3. Where is the suspect’s DNA sample taken from in the animation? ______
   a. Why here?

4. List the materials you will need to perform DNA extraction:

5. This solution is added to burst the cells open and means “to separate”:

6. The lysis solution contains two important ingredients: _____________________________
   a. Explain their function:

7. NaCl causes the proteins to _____________________________.

8. Why were 2 tubes added to the microcentrifuge?

9. After the first centrifugation, the ____________ is found is the supernatant while the ____________ is found as a solid pellet at the bottom of the tube.

10. To isolate the concentrated DNA, ____________ is added. Because DNA is not soluble in the solution, the DNA will ____________________.

11. Following the second round of centrifugation, the ______________ is now found in the pellet at the bottom of the tube.
Lab: DNA Extraction of Wheat Germ

A complete copy of DNA is found in every cell, except red blood cells, in any organism. In order to release the DNA for analysis, scientists must break open the cells and remove structural proteins and enzymes that interfere with the DNA structure. This simplified procedure releases a great deal of DNA so that you can see it. It allows observation of DNA’s physical and chemical properties. It does not, however, purify the sample enough for the strict standards of a research or forensics lab.

Materials

- 250 ml beaker
- hot plate
- Adolph’s natural meat tenderizer
- non-roasted wheat germ
- ice cold 95% ethanol
- thermometer
- 15 ml test tube
- glass stirring rod
- Palmolive detergent
- distilled water
- test tube rack or 250 ml beaker
- graduated cylinders (10 ml and 100 ml)

Procedures

1. Add 100 ml distilled water to a beaker and heat to 50-60°C. If your water gets to hot what will happen?

2. Add 1.5 g wheat germ and mix until dissolved.

3. Add 5 ml detergent. Maintain 50-60°C temperature and stir for 5 minutes.

4. Add 3 g meat tenderizer. What enzyme is in the meat tenderizer? What is its function?

5. Maintain the 50-60°C temperature and stir for 10 minutes.

6. Remove from heat.

7. Add 6 ml of the solution to a test tube and cool to room temperature.

8. Pour 6 ml ice-cold ethanol carefully down the side of the tube to form a layer.

9. Let the mixture sit undisturbed 2-3 minutes until bubbling stops.

10. The DNA will float in the alcohol. Swirl a glass-stirring rod at the interface of the two layers to see the small threads of DNA. * Place DNA in 1 ml of ethanol in an ependorf tube.

11. Repeat #7-10 until you have collected enough DNA (about the size of a pea).

12. Store samples in freezer.

*Draw your observations below:

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Post-Lab: DNA Extraction

1. We can’t really see a DNA molecule under the microscope unless it is tightly coiled into a chromosome. Why is the DNA only visible after the addition of ethanol?

3. Why was the wheat germ raw (uncooked)?

4. What part of the cell does the detergent work on?

5. Predict what would happen if the sample was heated in boiling water.

6. What was the purpose of heating the sample?

7. Where is the first place you are able to see DNA?

Extension:
1. Bring in a fruit, vegetable or meat sample from your home.
2. Design an experiment to extract DNA from your sample.
3. Take pictures at several stages during your procedure.
4. Attach pictures in the right column and describe each step.
Experiment: Tricks of the Trade

Raw wheat germ
- Can be purchased at a health food store or some large supermarket (toasted wheat germ does not work).

1 small plastic cup or beaker
- 3 oz. bathroom cups. Paper cups tend to soften due to the hot water and detergent, which remove the wax coating.

1 small (100 or 150 mL) beaker or cup
- To make initial mix of detergent, salt and water.

Non-iodized table salt
- Sea salt or pickling salt; if none is available, the iodine shouldn’t interfere with the reaction.

Hot but not boiling distilled water or tap water
- Approximately 20 mL per student.
- 50-60 degrees C—do not use water hotter than indicated as it will damage the DNA.
- Test your tap water—it may be hot enough right from the tap.
- The water will become cooler during the extraction procedure, but this does not matter.

Dishwashing detergent
- The following liquid soap products have been tested and work well: Lemon Fresh Joy, Woolite, Ivory, Shaper, Arm & Hammer, Herbal Essence shower gel by Clariol, Tide, Dish Drops, Kool Wash, Cheer, Sunlight Dish Soap, Dawn, Delicate, All, and Ultra Dawn.
- Liquid products that do not work well are Life Tree, Shout, Shaklee, Sunlight Dishwasher, and LOC. Powdered detergents do not work in this protocol.

About 1 mL meat tenderizer containing papain - 6% solution
- Papain is the enzyme that will break down the structural proteins and other enzyme.
- Check the ingredient list. Not all meat tenderizers contain papain.

Glass stirring rod or other stirrer
- You may substitute anything that can be used to stir- spoons, skewers, popsicle sticks, etc.
- Eyedropper or pasteur pipette and bulb.

10 mL ice cold ethanol in a test tube on ice.
- The colder the alcohol, the more likely the DNA will precipitate. You can add salt to the ice to make it even colder, or keep it in the freezer until right before you use it.
- It is better to use 95% ethanol or Everclear grain alcohol but 70% ethanol or 70-90% isopropyl alcohol will work, too.

Large paper clip hook
- Used to spool the DNA.
- A glass stirring rod is usually recommended because the charge on the glass attracts the DNA, but it tends to slide off as it is pulled out of the alcohol.
- A glass pasteur pipette with the end curved into a hook over a bunsen burner may work even better.
- Paper clips are easily available but a thinner wire, if it is available, is easier to bend (small paper clips are too short).
- The hook must be fairly narrow if you want students to store their DNA in a microcentrifuge tube (see lab extensions).

Sealable container (optional) such as a tube, vial or jar to store DNA.
- To save DNA for restriction analysis experiments (see lab extensions) or to teach students proper storage of DNA.

Paper towels or filter paper – for drying DNA.
- Paper towels can be considered sterile until touched by human hands. If you choose to have students dry the DNA, it is not necessary to spool it.