

DNA -- Teacher Preparation Notes

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As background for this activity, students should know that DNA is the genetic material and DNA is contained in chromosomes inside the nucleus inside a cell. We recommend that this activity be followed by our activity, "From Gene to Protein -- Transcription and Translation", which continues discussion of the importance of the base-pairing rule and explains how the sequence of nucleotides in a gene determines characteristics such as sickle cell anemia.

Equipment and Supplies:

Sports Drink like Gatorade (10 mL per student)
Liquid dish soap (0.25 mL per student)
Meat Tenderizer (a pinch per student)
70-95% isopropyl or ethyl alcohol (4 mL per student)
String for necklace (2.5 ft per student)
3 oz. Dixie cups (1 per student)
Tub of ice, freezer, or refrigerator (1)
Tub for dirty test tubes (1)
Bleach (1% bleach solution to sterilize test tubes)
Small test tubes (tubes need to hold a minimum of 15 mL) (1 per student)
Test tube rack (1 per group)
0.5-1.5 mL fliptop microcentrifuge tubes (1 per student)
Transfer pipettes (1 per group)
Gloves (1 per student)

Items above not found locally can be purchased from Carolina Biological among other places:

73-0006	12 × 75 mm Test Tubes	\$24.40 Pack of 72
19-9684	1.5-mL Microcentrifuge Tubes	\$43.65 Pack of 1,000
21-5240	0.5-mL Microcentrifuge Tubes	\$71.00 Pack of 1,000
73-6984	Pipettes, Graduated, Small	\$4.35 Pack of 100

Before Class:

1. Cut string into 2.5 ft segments.
2. Set up a bucket of ice to keep alcohol cold or put alcohol in the freezer/refrigerator until needed.
3. Pour a small cup sports drink for each student.

During class:

1. Distribute cups of sports drink to each student. It is important for each student to swish the drink in his or her mouth for at least a minute in order to obtain enough cheek cells.
2. Distribute a test tube rack with one test tube per student to each group. Distribute one glove to each student. Pass around the soap and meat tenderizer. Alternatively, you can have a station somewhere in the classroom where the students can access the soap etc.
3. After at least 10 minutes (when the students have completed the "DNA structure" portion of the worksheet), pass around the cold alcohol and pipettes.
4. After 10 minutes (when the students have completed the "DNA replication" portion of the worksheet), distribute one microcentrifuge tube and piece of string to each student.

¹ These teacher preparation notes and the related student handout are available at http://serendip.brynmawr.edu/sci_edu/waldron/.

5. Assist students' transfer of their DNA to their microcentrifuge tubes using the pipettes. It helps to twirl the DNA around the end of the pipette to get a large wad together before sucking the DNA into the pipette. Warn the students to be gentle while pipetting so they do not damage the fragile strands of DNA. Inexperienced pipettors have a tendency to blow air into the liquid and suck up and expel the DNA several times in the test tube before transferring it to the microcentrifuge tube; this tends to break the DNA strands.
6. Put on a pair of gloves and collect the test tube racks from the students. Pour test tube contents out down the sink, rinse the test tubes, and place them in a tub of 1% bleach solution for 10 minutes to sterilize them for the next class. (You may want to assign this job to a student).
7. Remove test tubes from bleach water and invert them in the racks to dry for the next class.
8. Return the alcohol to the ice bucket or freezer/refrigerator.

Supplemental Activity

You may also want to extract DNA from other organisms, such as peas or strawberries, to show your students that DNA from different organisms looks the same. This is also helpful to provide DNA to make a necklace for a student whose own DNA extraction did not work (e.g. due to insufficient cheek cell collection). For instructions to extract DNA from other sources see "How to Extract DNA from Any Living Thing" at the Genetic Science Learning Center <http://learn.genetics.utah.edu/units/activities/extraction/>

Additional Information

The proteases in the meat tenderizer not only digest histones (the DNA wrapping proteins), but also break down the enzymes which digest DNA.

Cold alcohol helps to precipitate the DNA molecules by reducing the temperature and dehydrating the salty soapy solution of DNA immediately under the alcohol layer. The high salt concentration, from the sports drink and meat tenderizer, is also important since DNA molecules are negatively charged and the salt neutralizes the repulsion among the negatively charged strands of DNA and allows the DNA to clump together.

Genetic Science Learning Center has a Frequently Asked Questions page including answers to questions about Trouble-shooting, Understanding the Science behind the Protocol, Comparing the DNA Extracted from Different Cell Types, and Real-life Applications of the Science of DNA Extraction. <http://learn.genetics.utah.edu/units/activities/extraction/faq.cfm>

For more detailed information about DNA extraction and helpful figures for explaining how detergents break down lipids see <http://learn.genetics.utah.edu/units/activities/extraction/> and <http://www.biorad.com> (search "genes in a bottle").

DNA Teaching Points

- DNA is a nucleic acid made of two strands of nucleotides wound together in a spiral called a double helix.
- Each nucleotide is composed of a five carbon sugar molecule known as deoxyribose, a phosphate group, and one of four different nitrogenous bases: adenine, thymine, guanine, and cytosine.
- Nucleotides in the two strands follow the base-pairing rule: A with T and G with C.
- During DNA replication DNA polymerase produces two identical DNA double helices.
- DNA polymerase forms a new DNA strand, using the old DNA strand as a template, by adding complementary base pair nucleotides to a growing DNA strand.
- The DNA of different organisms differs only in the sequence of nucleotides.