DNA EXTRACTION

INSTRUCTIONS

Overview:

Students will harvest cheek cells and conduct a lab exercise to extract DNA from living cells. Students will learn that cells contain chromosomes that are comprised of a long strand of DNA.

Objectives:

The student will:

- Extract DNA from their epithelial cheek cells; and
- Recognize chromosomes are composed of a long strand of DNA.

Targeted Alaska Grade Level Expectations:

Science

[9] SC1.1 The student demonstrates an understanding of how science explains changes in life forms over time, including genetics, heredity, the process of natural selection, and biological evolution by recognizing that all organisms have chromosomes made of DNA and that DNA determines traits.

Vocabulary:

chromatin - the complex of DNA and proteins that make up a chromosome

chromosome - a gene carrying structure that consists of a very long sequence of DNA and protein found in a cells nucleus. Most humans have 23 pairs (46) chromosomes in their somatic cells

DNA - deoxyribonucleic acid is a double stranded, helical nucleic acid molecule capable of replicating and determining the heredity of cells

enzyme - a protein produced by cells that act as catalysts to bring about a specific biochemical reaction

extraction - a method of separating one or more components from a mixture

genetic trait - a physical characteristic caused by the expression of one or many genes

gene- a discrete unit hereditary information consisting of a sequence of nucleotides that code for a protein or trait

karyotype - an organized profile of an individual's chromosomes arranged by size from the largest to smallest

lyse - to break open or cause the destruction of a cell membrane

nucleus - the chromosome containing organelle of a eukaryotic cell

protein- a large chain of amino acids necessary for all living things

Whole Picture:

People have long observed that certain traits were passed from one generation to the next. Farmers, in particular, were aware of the phenomenon of inherited traits. Their knowledge and careful crossbreeding produced crops and livestock with specific useful traits. For example, by choosing different traits, farmers produced broccoli, cabbage, and brussels sprouts from the wild cabbage plant. In the 1850's, Gergor Mendel began empirically experimenting with heredity. Mendel is often considered the founder of modern genetics by showing how certain traits can be passed on in discrete units and that some traits are inherited independent of each other. It wasn't until 1902 that Water Sutton made the connection between chromosomes and inherited traits. Soon afterwards in 1911, Thomas Morgan found that genes within the chromosomes are the functional units of heredity.

DNA has three main roles in heredity: storage, copying, and transmitting.

1. DNA stores information for operating the cell and entire organism. Genes, the functional unit of heredity, carry information needed to produce the proteins that determine eye color, blood type, and much more. Genes also control the process of development, controlling when to turn on some traits and when to turn

off others. Genes are found on chromosomes that consist of a very long sequence of DNA wrapped around proteins called histones.

2. Before a cell divides it first must make a copy of the chromosomes. DNA is found in the nucleolus of the eukaryotic cells. When the cell is in interphase DNA is loosely coiled and wrapped around proteins call histones. This DNA and protein complex is called a chromatin. When a cell begins the process of dividing the chromatin becomes super coiled and forms chromosomes, which are visible with a light microscope. A human body consists of approximately 10- trillion cells. All of these cells originated from a single cell.
3. Chromosomes are transmitted from parents to offspring through sexual or asexual reproduction. In humans, the X and Y-chromosomes determine gender. Generally, two X chromosomes result in female while one X and one Y result in a male. While we can't always see DNA, we can often observe the results of the traits that are expressed. Genes control genetic traits such as blood type, eye color and the ability to taste certain chemicals. Other traits such as height are influence by both genes and the environment.

Materials:

Activity 1

- Clean drinking water, 500 mL
- Eye protection (1 per student)
- Disposable gloves (1 pair per student)
- 10 mL pipette or eyedropper (1 per group)
- Clean Dixie cup or glass (1 per student)
- 15 mL test tube (1 per student)
- Test tube rack (1 per group)
- Clean toothpick, straw (one per group)
- 70-95% isopropyl alcohol (rubbing alcohol) stored at cold temperature (4 mL per group)
- Blue dye (optional)
- Salt (15 mL per student)
- Clear liquid dish soap (0.0 mL per student)
- Meat tenderizer (1 pinch per group)
  Note: pineapple juice may be substituted for meat tenderizer
- Computer
- Digital projector or overhead projector
- STUDENT INFORMATION SHEET: "Extract DNA"
- STUDENT WORKSHEET: "Matching Chromosomes"
- VISUAL AID: "Unraveled DNA"

Activity 2

- Computer with Internet access
- The website http://learn.genetics.utah.edu/content/begin/traits/karyotype/

Pre-Engagement

Once students enter the classroom, ask them how small cells and DNA are? Project the following website to illustrate the scale of cells and chromosomes. http://learn.genetics.utah.edu/content/begin/cells/scale/

Pre-Assessment

Pass out the KWL chart and have students fill in the "K" and "W" for the three questions:

- How are DNA and chromosomes related?
- Where are chromosomes and DNA located?
- Why should I care about chromosomes and DNA?

After students have had time to write down their ideas, have them share their thoughts. Direct the conversation into the lab activity (see below).

Activity Procedure:

Part 1:

1. From the KWL discussions explain that DNA (deoxyribonucleic acid) determines genetic traits for living things and a chromosome is a very long strand of DNA wrapped around proteins call histones. Display VISUAL AID: "DNA and Chromosomes". Discuss that most humans have 23 pairs of chromosomes for a total of 46.
2. Discuss with students that DNA is essential for living things. Ask students if we can observe DNA without a microscope? Nearly all plant and animal cells are too small to see with the naked eye, but cells have a lot of DNA. DNA is usually wrapped and tightly coiled but if you were to unwind a chromosome from a single cell and stretch it out, the DNA double helix would stretch out to approximately 6 feet (2 m). Remember you have about 100 trillion cells in your body and most have their own DNA. If you multiplied 6 feet by 100 trillion you would get about a billion miles of DNA.
3. Ask students if they have any ideas on how they might uncoil chromosomes. Write suggestions on the board. If they do not suggest it, write 'break open cells' on the board. After students have finished suggesting ideas, propose they break the cells open and chop up the chromosomes to uncoil the DNA.
4. Ask students if there are any organisms in class they could easily and safely gather cells from to extract DNA.

   NOTE: This lab calls for students to harvest cheek cells and requires students to swish a saline solution in their mouths for 1 minute. If there are lab safety concerns that preclude this activity then a substitute of blended and filtered split peas or other substitute should be used.

5. If no one suggests humans write humans on the board and explain that they will gather their own cheek cells and extract DNA. This process will be painless.
6. Review lab safety with the class.
7. Hand out STUDENT LAB: "Extract DNA" and STUDENT WORKSHEET: "Extraction Results".
8. Review the procedure for extracting DNA from cells from TEACHER INFORMATION SHEET: "Extract DNA" and remind students that this procedure would work on other organisms and not just on humans.
9. After students have completed the DNA extraction have students share their extraction results with the class.

   Activity Response Question: Ask students to write a short paragraph describing their response extracting their DNA. They can begin their response with "I was surprised to learn…" or "I learned that…" or "I wonder if…"

10. After students have completed the DNA extraction activity and have cleaned up their area tell the students that after observing their own DNA after it has been unraveled they will observe photographs of intact chromosomes called karyotypes.

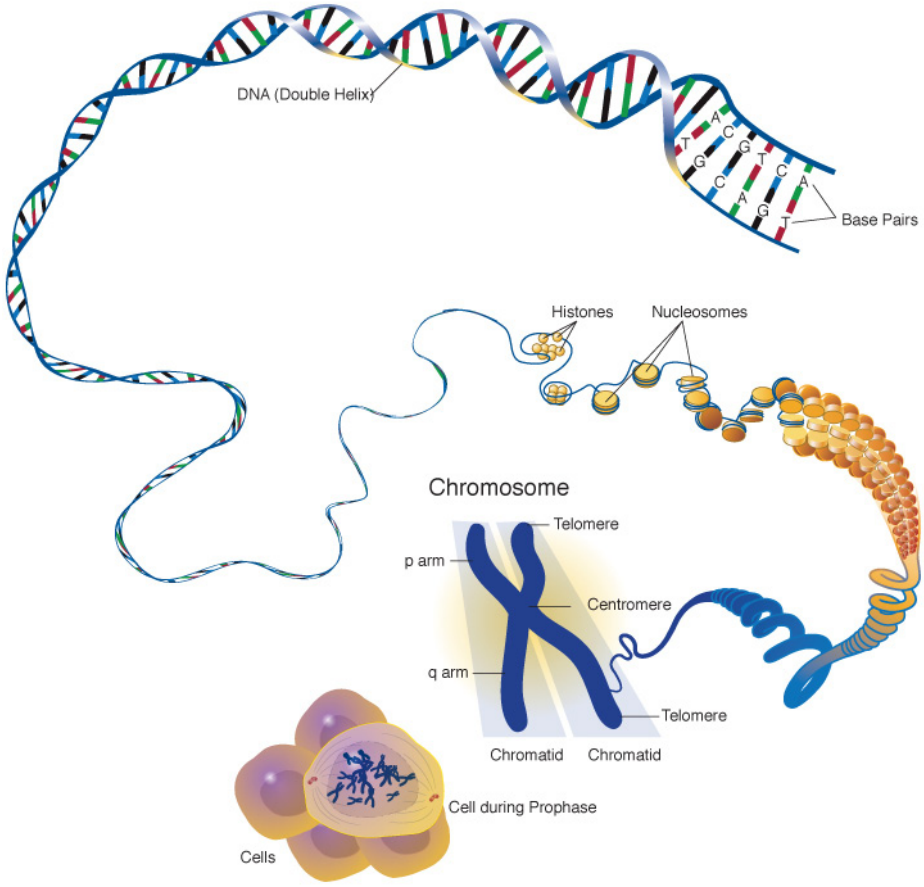
Part 2:

1. Once students have cleaned their lab station, direct them to the website http://learn.genetics.utah.edu/content/begin/traits/karyotype/
2. In this exercise they will create a karyotype of intact chromosomes by matching chromosomes by size and banding patterns.
3. After students complete the exercise review the process of DNA wrapping around proteins to produce a chromosome. Tie in the extracted DNA samples to your talk.
4. Have students return to the KWL chart presented at the beginning of class and have them fill in the "L" column. For each question, students must identify and explain at least one answer. Use the KWL chart as an "exit card."

Extension Ideas:

1. An interactive virtual gel electrophoresis lab activity (http://learn.genetics.utah.edu/content/labs/gel/).
2. Karyotyping activity where students match chromosomes and diagnose genetic disorders (http://www.biology.arizona.edu/human_bio/activities/karyotyping/karyotyping.html).
3. A more in-depth look into chromosomes and genetics (http://www.nature.com/scitable/topicpage/chromosome-mapping-idiograms-302).

DNA AND CHROMOSOMES



From: http://www.genome.gov/Glossary/resources/chromosome_lg_adv.jpg

1. You should have the following materials
    a. Drinking water
    b. Table salt 15 mL (1 tablespoon)
    c. Clean drinking water, 500 mL
    d. Eye protection (1 per student)
    e. Disposable gloves (1 pair per student)
    f. 10 mL pipette or eyedropper (1 per student)
    g. Clean Dixie cup or glass (1 per student)
    h. 15 mL test tube (1 per student)
    i. Test tube rack (1 per student)
    j. Clean toothpick, straw (one per student)
    k. 70-95% Isopropyl alcohol (rubbing alcohol) stored at cold temperature (4 mL per student)
    l. Clear liquid dish soap (0.0 mL per student)
    m. Meat tenderizer (1 pinch per student)
2. Remember to be aware of lab safety. Isopropanol (rubbing alcohol) is poisonous and will give off fumes. Ensure adequate ventilation in the classroom and cap the alcohol bottle when not in use.
3. Combine 500 ml of clean drinking water and 15 mL (1 tablespoon) of table salt. Stir with a clean stir-stick or straw until the salt is dissolved.
4. Pour 15 mL of saline water solution into Dixie cup or other clean drinking cup.
5. Have students gargle and swish the saline water in their mouth for one minute. Remind them to not swallow the water. After one minute instruct them to carefully spit the water back into the empty cup.
6. Next they should carefully transfer the 7 mL of the content of the cup into a test tube.
7. To remove the lipid cell membrane Dip the stir-stick in the dishwashing detergent and carefully transfer a few drops into the test tube. Gently stir 2-3 times.
8. Add a pinch of meat tenderizer (or other protease enzyme containing material such as pineapple juice) and gently stir until dissolved.
    a. Meat tenderizer contains enzymes that denature (breaks up) proteins. DNA in cells is wrapped around proteins called histones and enzymes in meat tenderizers break up the histones allowing the DNA to unwind.
9. Use a pipette or eyedropper to carefully transfer 4 mL of cold isopropyl alcohol to the test tube.
    a. Instruct students to slowly add the alcohol to their test tube by tilting the tube and letting the alcohol flow down the side. Do not mix the alcohol into the water. Alcohol is less dense than water and will float on top of water.
10. Look carefully at the area of where the alcohol and water meet. You should see long strings of white material forming. This is the DNA sample. Carefully insert a stir-stick and in a smooth motion twist the DNA onto the stick.
    a. DNA is negatively charged and will wrap around the positive sodium ion from the salt added in a previous step. When the clumped DNA molecules encounter alcohol, they precipitate out of solution and you are able to see your DNA without a microscope.

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NAME: _____ STUDENT WORKSHEET

MATCHING CHROMOSOMES

Directions: *At a computer, go to the following website* to learn about chromosomes. http://learn.genetics.utah.edu/content/begin/traits/karyotype/

1. Now that you have un-wound DNA from chromosomes, it's time to look at intact human chromosomes. An organized picture of someone's chromosomes is called a Karyotype. The chromosomes are arranged from the largest to smallest.
2. Go to the following web site: http://learn.genetics.utah.edu/content/begin/traits/karyotype/.
3. You will drag the unnumbered chromosomes from the left side and try to match it to the numbered chromosome on the right side. Remember that humans have 23 pairs of chromosomes for 46 total. We get one chromosome of the pair from our mother and the other matching chromosome from our father.
4. Once you have matched the chromosomes to make a karyotype, complete your KWL chart.

	Know	**W**ant to know	**L**earned
How are DNA and chromosomes related?			
Where are chromosomes and DNA found?			
Why should I care about chromosomes and DNA?			