The Young Scientist Program - Teaching Kits
http://ysp.wustl.edu
Washington University School of Medicine
Funding provided by The Leon Lowenstein Foundation

DNA Extraction
Teacher Handout

Module Overview
In this lab, students will break open the cells from strawberries or peaches and isolate the DNA from the cell nuclei. After this lab, students will be able to answer questions like: Is there DNA in your food? How do you know? and If DNA is so small it fits in one cell, how are we able to see it with our eyes after extraction?

Curriculum Links
Missouri Science Standards
3.3.B.a. Describe the chemical and structural properties of DNA (e.g., DNA is a large polymer formed from linked subunits of four kinds of nitrogen bases; genetic information is encoded in genes based on the sequence of subunits; each DNA molecule in a cell forms a single chromosome)
3.3.B.b. Recognize that DNA codes for proteins, which are expressed as the heritable characteristics of an organism
3.3.C.a. Recognize the chromosomes of daughter cells, formed through the processes of asexual reproduction and mitosis, the formation of somatic (body) cells in multicellular organisms, are identical to the chromosomes of the parent cell

Next Generation Science Standards
HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Goals
There are three main take home messages we hope the students come away with. Before the hands on portion, take some time to discuss what they will be doing, and why it is valuable. Please refer to the online video for some suggestions on how this conversation might go, and a demonstration of the experiment.

1. ALL living things have DNA-it is the blue print from which all living things are built.

You can try getting this point across by first asking if anyone knows what DNA is. After taking some of their answers, make sure to describe that our DNA is found in the cell nucleus, and is what encodes our genes, which determine things that make us unique from other people, like our hair color and our eye color etc. Interestingly only about 0.1% of our DNA is actually different! However, because we do have these unique differences, DNA can be a useful tool for many things: crime solving, predicting illnesses, identifying family members and more.

The study of genes, the DNA that makes these genes, and the differences people have because of those genes, is called genetics.

2. ALL cells within an organism have the same amount of DNA, wound up within a certain number of chromosomes found in the nucleus.

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This has to be true because all of us (and all other living things) first start out as only one cell, with all the information needed to become an entire being. This cell divides to create billions of cells, which make up our bodies. When a cell divides, the two resulting cells (daughter cells) each contain a copy of the same DNA that was in the nucleus of the first (parent) cell. The cells eventually become different (for instance the cells in your eyes are different form the cells in your lungs) by expressing different genes (encoded by areas of DNA) and not expressing others.

3. Science is accessible and useful!

We are using everyday products to extract real DNA from real cells. Even in crime labs the concepts are the same, and the ideas are simple.

Timing
This module takes about 60-90 minutes to complete

Kit Materials
Included by the Young Scientist Program
Frozen strawberries (a small handful) **THAWED**
Canned peaches (2-3 slices, a small handful)
2 plastic cups
water
shampoo
salt
cheese cloth or gauze
rubbing alcohol (**COLD**)
plastic gloves
wooden stick
paper towels

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Lesson Design Tool

Course: Teacher:
Week of: Grade Level:

CONTENT AREA:	**DIFFERENTIATED INSTRUCTION/CROSS CONTENT INTEGRATION**
Goals: Big Idea/Concept	*HOW will you teach the content? (groups, strategies, accommodations, variation, etc.)*
ALL living things have DNA-it is the blue print from which all living things are built. ALL cells within an organism have the same amount of DNA, wound up within a certain number of chromosomes found in the nucleus. Science is accessible and useful.	Short lecture on how all living things are made of DNA, each cell in an organism has the same DNA, cells express this DNA differently which leads to all of the different functions cells carry out in multicellular organisms. In small groups, extract DNA from strawberries and/or peaches. Individually answer questions and discuss as a large group.
Grade Level Expectation/Objective: *(WHAT are you going to teach?)*	
3.3.B.a. Describe the chemical and structural properties of DNA (e.g., DNA is a large polymer formed from linked subunits of four kinds of nitrogen bases; genetic information is encoded in genes based on the sequence of subunits; each DNA molecule in a cell forms a single chromosome 3.3.B.b. Recognize that DNA codes for proteins, which are expressed as the heritable characteristics of an organism 3.3.C.a. Recognize the chromosomes of daughter cells, formed through the processes of asexual reproduction and mitosis, the formation of somatic (body) cells in multicellular organisms, are identical to the chromosomes of the parent cell	
Essential Question(s)/DOK: *Higher Order Questions (scaffolded questions to get to Big Idea)*	
Is there DNA in your food? How do you know? If you could look at the DNA code for each of your strawberry's cells, would it be the exactly the same? If you could look at the DNA code for all of the strawberries in class, would it be exactly the same? If DNA is so small it fits in one cell, how are we able to see it with our eyes after extraction? Why do we wear gloves when working with DNA? What are some everyday examples for using extracted DNA?	
Assessment/Performance Task: *How will students SHOW what they have learned?*	**Teacher Reflections/Student Work Analysis**
Responses on handout/discussion questions	

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Vocabulary	**Vocabulary Strategies**	**Reteaching Strategies**
DNA, double helix, nucleotides, chemical base, base pairs, chromosome, cell nucleus, gene expression, nuclear envelope, plasma membrane, proteins, replication		
Technology/Manipulatives		
Fruit, soap, salt, alcohol, cheesecloth		

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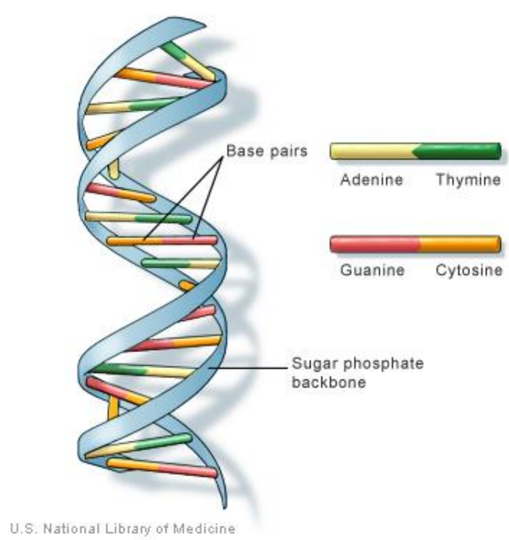
Background information
DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other organisms, including plants, fungi, animals, and bacteria. DNA contains the biological instructions that make each species unique. DNA, along with the instructions it contains, is passed from adult organisms to their offspring during reproduction. Nearly every cell in a person's body has the same DNA.

Most DNA is located in the cell nucleus (where it is called nuclear DNA) surrounded by a wall, called a nuclear envelope. The nucleus sits in the middle of a cell. The whole cell is surrounded by a plasma membrane, which serves as a barrier keeping the cell's contents inside protected from the outside environment. Because the cell is very small, and because organisms have many DNA molecules per cell, each DNA molecule must be tightly packaged. This packaged form of the DNA is called a chromosome. DNA spends a lot of time in its chromosome form. But during cell division, DNA unwinds so it can be copied and the copies transferred to new cells. DNA also unwinds so that its instructions can be used to make proteins and for other biological processes.

Nucleotides and the Double Helix
The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Human DNA consists of about 3 billion bases, and more than 99 percent of those bases are the same in all people. The order, or sequence, of these bases determines the information available for building and maintaining an organism, similar to the way in which letters of the alphabet appear in a certain order to form words and sentences.

DNA bases pair up with each other, A with T and C with G, to form units called base pairs. Each base is also attached to a sugar molecule and a phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide. Nucleotides are arranged in two long strands that form a spiral called a double helix. The structure of the double helix is somewhat like a ladder, with the base pairs forming the ladder's rungs and the sugar and phosphate backbone molecules forming the vertical sidepieces of the ladder.



Replication, translation and the cell
An important property of DNA is that it can replicate, or make copies of itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases. This is critical when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell. Specific chunks of the DNA sequence, called genes, can be translated into proteins, generating all the components required for a cell to function and live. Each gene is like a word in the sentence (or paragraph!) that is a chromosome. It is thought that humans have 30,000 to 40,000 genes in the human genome. There are normally 23 pairs of chromosomes in the human genome. Cells are the

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basic building blocks of all living things. The human body is composed of trillions of cells. They provide structure for the body, take in nutrients from food, convert those nutrients into energy, and carry out specialized functions.

DNA fun facts

- There are about 2 meters (6 feet) of linear DNA in each cell of your body! Think of how much in all your cells combined!!

- James Watson and Francis Crick are often credited with "discovering" the structure of DNA, but their "discovery" would not have been possible without the work of a third scientist, Rosalind Franklin. She took X-ray pictures of DNA molecules, providing the key to solving its structure.

- If the DNA from all the cells in your body was streched out, it couuld reach to the sun and back 700 times!

- Any two individuals differ in about three million - 3 x 10 6 bases (0.1%).

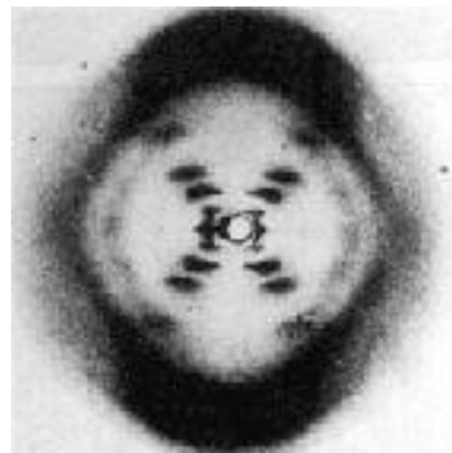

Photo from:
http://www.npr.org/programs/atc/features/2002/oct/darklady/

References for more info

Cells Alive-how big is a cell? http://www.cellsalive.com/howbig.htm
The Mad Scientist Network http://www.madsci.org/
The Exploratorium http://www.exploratorium.edu/
Send your friends a DNA-o-gram http://www.dna2z.com/DNA-o-gram/
National Human Genome Research Institute http://www.genome.gov/25520880
NCBI's Science Primer http://www.ncbi.nlm.nih.gov/About/primer/index.html

Experimental overview

In this lab, students will break open the cells from strawberries or bananas and isolate the DNA from the cell nuclei.

Break open the cells. Physically mashing up the produce breaks open the cells. This allows us to access the DNA that is in the nucleus of the cell.

Get rid of proteins: Adding the soap (a detergent) and salt breaks open proteins and dissolves the cell membranes. Detergents, like soap, are used ALL the time to denature or breakdown proteins and lipid membranes.

Filter unwanted material: Cheese cloth is used to filter out other parts of the cell. Cells are complex and if you only want DNA you need to eliminate the proteins and other cellular components.

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Precipitate DNA: Alcohol is used to precipitate the DNA. DNA is soluble in water but not alcohol, so by adding alcohol you can see the DNA come out of solution

Materials per group
Frozen strawberries (a small handful) **THAWED**
Canned peaches (2-3 slices, a small handful)
2 plastic cups
water
shampoo
salt
cheese cloth or gauze
rubbing alcohol (**COLD**)
plastic gloves
wooden stick
paper towels

NOTE: Be sure to RINSE the produce, as the sugars they are in may reduce your DNA extraction.

Safety
Wear glove, this can be messy. After addition of soap and salt, the produce is NOT edible. Do not drink the liquids. Be careful with the alcohol, it can sting if gotten in the eyes or in cuts.

Protocol
Prior to the experiment, the frozen strawberries must be thawed. This takes about 30 minutes with the bag in warm water. Then, canned and frozen fruit **must be rinsed briefly to eliminate syrup/sugar**. You may want to do this before the students arrive, or have them do it individually if access to a sink and space/time allow. Putting students in groups of two may be helpful, and the pairs can compare peaches to strawberries at the end of the experiment.

1. Put on gloves and squish the produce into one of the plastic cups. Continue to squeeze the pieces until the fruit pieces are the consistency of a smoothie (small chunks are okay).

2. Add an equal volume of water (just guess, it doesn't have to be exact).

3. Add 2 small squirts of shampoo and about a teaspoon of salt (measure the salt in your hand). Mix this up *gently* with your gloved hand or stick.

4. Strain the mixture through a layer of cheesecloth into the second plastic cup. Have one lab partner hold the cheesecloth while another carefully pours the mixture in the center of the cheesecloth. Allow the liquid to drip through. After most of the liquid has dripped through, you may gently squeeze the cheesecloth to get more liquid out.

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5. Add an equal volume of **COLD** rubbing alcohol to the liquid. Gently swirl the cup or stir with the wooden stick. You should see strings/globs of clear DNA form and float to the top. Use the wooden stick to twirl the gooey DNA around and pick it up out of the liquid. This is DNA!

NOTE: If the materials were handled vigorously, the DNA may just be in floating chunks and difficult to see, not stringy gooey globs. Also, it is important that the alcohol is cold in order to get good precipitation of DNA.

Discussion Questions

1. What is DNA, and where is it found?

   DNA is the building block of life. It is found in the nucleus of every living cell.

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

   Yes; we know this because everything we eat was once alive, or made of things that were alive, unless we eat rocks!

3. What did the DNA look like?

   Long stringy globs; snot; clear/white floaty stuff. Or maybe just floating chunks.

4. If DNA is so small it fits in one cell, how are we able to see it with our eyes after extraction?

   We smashed up a LOT of cells, and all the cells have DNA so we isolated a lot of DNA! Like if you tie a bunch of strands of string together to make a rope, you can see it from far away when you couldn't see and individual piece of string.

5. Were there any differences in the DNA you extracted from the strawberries compared to the peaches? Why do you think there were or were not any differences?

   You may get a lot of different answers. Color, amount etc. Usually, there is more gooey DNA from the strawberries compared to the peaches. This is likely due to the fact that strawberries have so many seeds on their surface that are full of cells and DNA, so for an equal mass of peaches and strawberries there are more cells in the strawberries.

6. Do you see any differences in the DNA of strawberries compared to peaches? Is there more from one or the other? Why might this be so?

   Answers will vary, however typically you will isolate much more DNA from the strawberries than the peaches, using roughly equal amount of both fruits to start. If we think about strawberries, this might make sense; strawberries are covered in seeds packed full of cells that could add to the amount of DNA we are able to isolate.

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7. What can we do with the DNA we isolate? Why is it valuable that we are able to isolate DNA?

   We can use the DNA in forensics (blood, saliva, skin) to solve a crime or to find missing or unknown family members, and test people and food for disease and illness.

8. Why do we wear gloves when doing science?

   We wear gloves for personal protection and often to protect the materials from the oils and DNA on our own hands.

9. Based on this lab, why do we shampoo when we shower?

   Detergents, like soap and shampoo, will be able to break down the grease and dirt built up in our hair.

10. Please include completed surveys with material you need to return, or scan and e-mail them to ysp.kits@gmail.com, or mail them to The Young Scientist Program, Washington University in St. Louis, Division of Biology & Biomedical Sciences, Campus Box 8226, 660 S. Euclid Ave., St. Louis, MO 63110.

Thanks!