KANSAS CORN STEM

Kansas Corn:
DNA, How is it Packaged?

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Kansas Corn: DNA, How is it Packaged?
Grade Level: Middle School

Overview
It is important for students to understand what DNA is and how all cells utilize it. One major difference in this DNA lab is that we attempt to build a physical and mental model of how DNA is packaged in cells. After building a model, the students then attempt to utilize their newly acquired knowledge of the structure and packaging of DNA to determine how to get DNA out of the cell.

Kansas College and Career Ready Standards
Disciplinary Core Ideas

- **MS-LS1-2.** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

Learning Objectives
- Students will learn that DNA is the storage molecule for genetic information in the cell.
- Students will create a model of the structure of DNA.
- Students will present their ideas on how to extract DNA from cells to the class.

Materials
- DNA, How is it Packaged? PowerPoint (available at www.kansascornstem.com)
- Saran wrap (long roll)
- 32 ping-pong balls (8 per group)
- 55-gal. clear trash bags
- Velcro
- Tape
- 1 Sharpie

Safety Considerations
Be aware of student allergies or seeds treated with chemicals.

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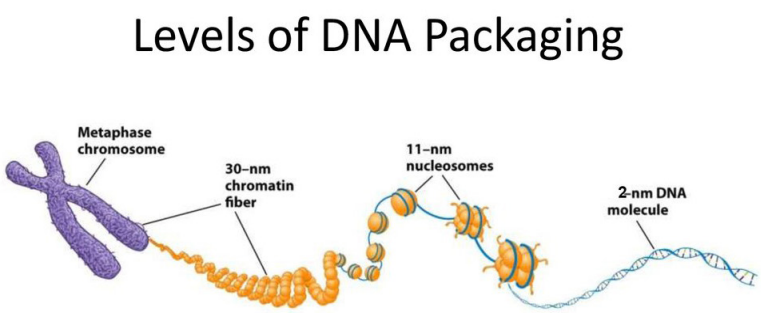
Background Information



Source: https://socratic.org/questions/what-are-chromatin-and-chromosomes-made-from

Article by Daily Science (2009)

In recent years, scientists have decoded the DNA of humans and a menagerie of creatures but none with genes as complex as a stalk of corn, the latest genome to be unraveled.

A team of scientists led by The Genome Center at Washington University School of Medicine in St. Louis published the completed corn genome in the Nov. 20, 2009 journal Science, an accomplishment that will speed efforts to develop better crop varieties to meet the world's growing demands for food, livestock feed and fuel.

"Seed companies and maize geneticists will pounce on this data to find their favorite genes," says senior author Richard K. Wilson, Ph.D., director of Washington University's Genome Center, who led the multi-institutional sequencing effort. "Now they'll know exactly where those genes are. Having the complete genome in hand will make it easier to breed new varieties of corn that produce higher yields or are more tolerant to extreme heat, drought, or other conditions."

Corn, also known as maize, is the top U.S. crop and the basis of products ranging from breakfast cereal to toothpaste, shoe polish and ethanol. The corn genome is a hodgepodge of some 32,000 genes crammed into just 10 chromosomes. In comparison, humans have 20,000 genes dispersed among 23 chromosomes.

The $29.5 million maize sequencing project began in 2005 and is funded by the National Science Foundation and the U.S. departments of agriculture and energy. The genome was sequenced at Washington University's

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Genome Center. The overall effort involved more than 150 U.S. scientists with those at the University of Arizona in Tucson, Cold Spring Harbor Laboratory in New York and Iowa State University in Ames playing key roles.

The group sequenced a variety of corn known as B73, developed at Iowa State decades ago. It is known for its high grain yields and has been used extensively in both commercial corn breeding and in research laboratories. The genetic code of corn consists of 2 billion bases of DNA, the chemical units that are represented by the letters T, C, G and A, making it similar in size to the human genome, which is 2.9 billion letters long.

But that's where much of the similarity ends. The challenge for Wilson and his colleagues was to string together the order of the letters, an immense and daunting task both because of the corn genome's size and its complex genetic arrangements. About 85 percent of the DNA segments are repeated. Jumping genes, or transposons, that move from place to place make up a significant portion of the genome, further complicating sequencing efforts.

A working draft of the maize genome, unveiled by the same group of scientists in 2008, indicated the plant had 50,000-plus genes. But when they placed the many thousands of DNA segments onto chromosomes in the correct order and closed the remaining gaps, the researchers revised the number of genes to 32,000.

"Sequencing the corn genome was like driving down miles and miles of desolate highway with only sporadically placed sign posts," says co-investigator Sandra Clifton, Ph.D., of Washington University. "We had a rudimentary map to guide us, but because of the repetitive nature of the genome, some of the landmarks were erroneous. It took the dedicated efforts of many scientists to identify the correct placement of the genes."

Interestingly, plants often have more than one genome and corn is no exception. The maize genome is composed of two separate genomes melded into one, with four copies of many genes. As corn evolved over many thousands of years, some of the duplicated genes were lost and others were shuffled around. A number of genes took on new functions.

Corn is the third cereal-based crop after rice and sorghum – and the largest plant genome to date – to have its genome sequenced, and scientists will now be able to look for genetic similarities and differences between the crops. "For example, rice grows really well in standing water but corn doesn't," explains co-investigator Robert Fulton, of Washington University. "Now, scientists can compare the two genomes to find variations of corn genes that are more tolerant to wet conditions."

The United States is the world's top corn grower, producing 44 percent of the global crop. In 2009, U.S. farmers are expected to produce nearly 13 billion bushels of corn, according to the U.S. Department of Agriculture.

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Procedures for Instruction
Length of Time for Preparation: 40 minutes
Length of Time for Classroom Teaching: 50 minutes

This lab involves 3 distinct activities. (1) Creating a structural model of DNA, (2) using a White boarding brainstorming session to design a method to extract DNA from canned corn, and (3) extracting DNA from canned corn.

Classroom Discussion
Introduce the topic and assess students for prior understanding.
Socratic Questioning:

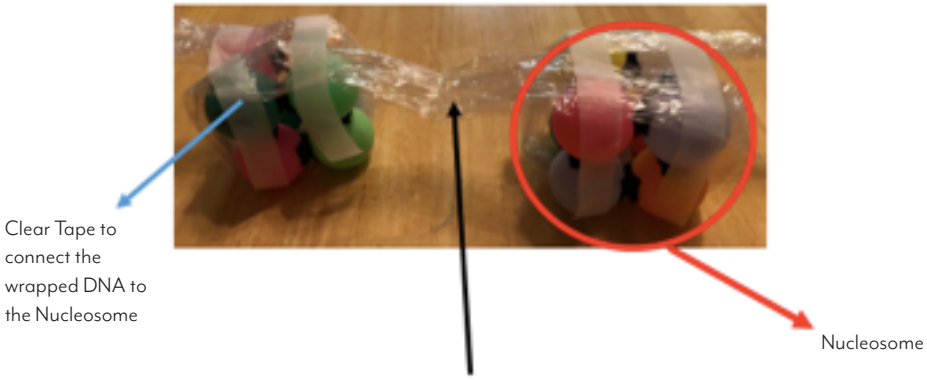
- What is DNA?
- Where can we find DNA?
- How is DNA stored?
- Is DNA the same for plants and animals?

Procedure for Lab
Modeling DNA Structure
Part 1. Creating a Model of DNA: Let's Make a Model of DNA!

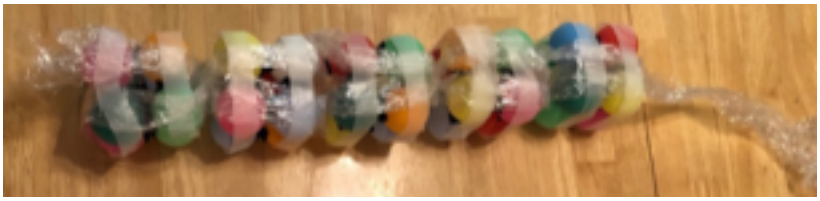
Procedure:

1. Each group will connect their eight ping-pong balls into the arrangement of a double stack of 4 (see photo). These stacks represent a nucleosome (made up of 8 histone proteins).

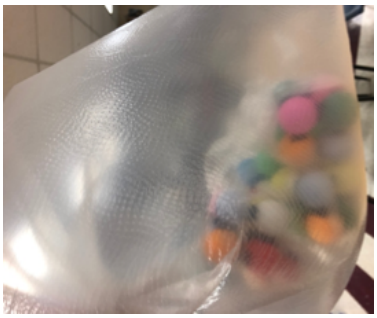
2. After all groups have their nucleosomes arranged, start with one group and pull out about 10 ft. of Saran wrap. Squeeze this into a long rope shape and wrap it around one of the nucleosomes (see photo). Continue with the Saran wrap and wrap all of the other nucleosomes in a sequence. After all of the nucleosomes are wrapped with the Saran wrap, use a couple pieces of clear tape to secure the nucleosomes to the saran wrap DNA. The Saran wrap represents DNA.



3. To show how a chromosome is formed, you will need to pull all of the nucleosomes together to make a condensed arrangement of the DNA. This is how a chromosome forms (just much more condensed).



4. When the arrangement is condensed, place the whole arrangement in a large 55-gal. clear trash bag. Try to fill the bag about half full of air. Twist the bag opening to close off the bag (you can tape this closed). The trash bag represents the nuclear membrane.



5. Take another clear trash bag and place your nucleus with DNA into this bag. You will also seal this bag by closing of the opening with tape. This outer bag will represent the cell membrane.

6. Looking at our class model, what are some barriers that we need to get through to get to the DNA?
   Cell membrane (outside bag) and nuclear membrane (inside bag).

7. What are those barriers made up of? (You might have to research what both of those membranes are made up of.)
   Bi-lipid Layers (fats)

8. What can we do to open up or get rid of those fats when attempting to get to the DNA? (Research how to break up bi-lipid membranes.)
   Detergent (soap) breaks apart bi-lipid layers

9. The nucleosomes are made up of histone proteins. If we want to extract DNA, we will need to get rid of those histone proteins. Propose a way to get rid of the histone proteins from the DNA. (Research how to get rid of the histone proteins from the DNA.)

Part 2. Brainstorming White board session to determine how to extract DNA.

Whiteboard explanations: all groups will write on a Whiteboard their content in the following format, and they will present their whiteboard explanations to the class for review.

Claim, Evidence and Reason (CER) Whiteboard Activity: Students are posed with a question they will test. They will write out their claim (hypothesis), provide evidence (their data), and reasoning.

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Activity question: How can you get the DNA out of the cell nucleus and then the cell?

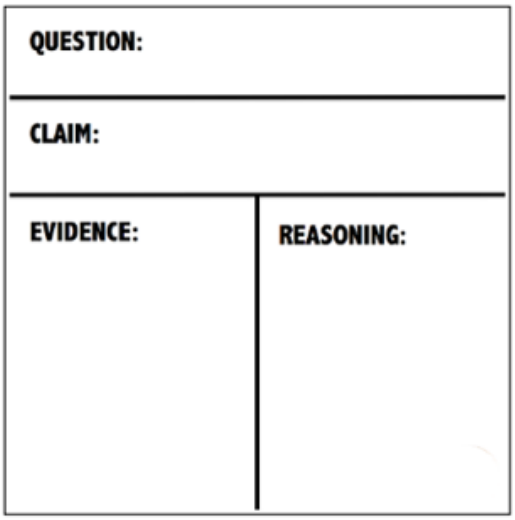

Figure 1. Whiteboard template

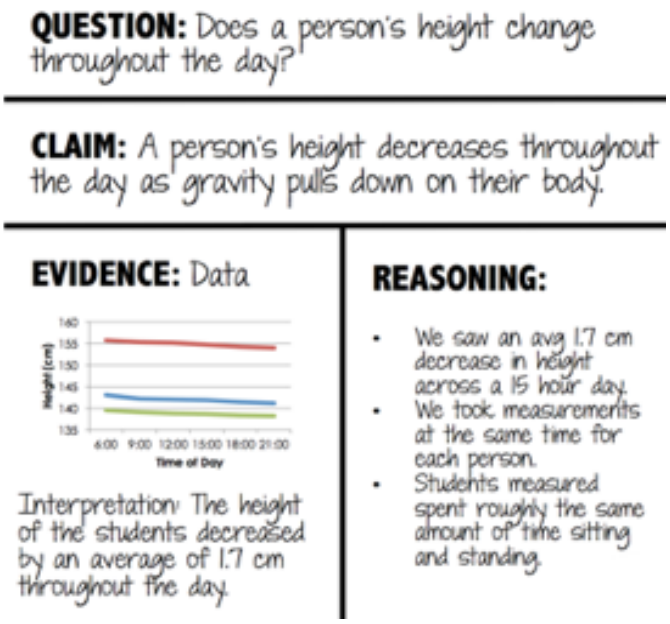

Figure 2. Whiteboard response example

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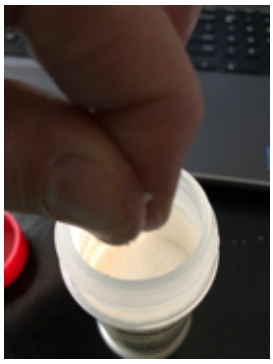
Part 3. Extracting DNA from canned corn.

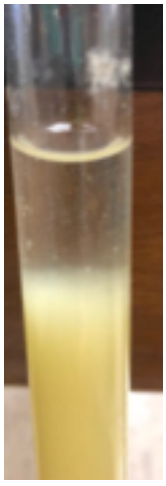
Procedure:

1. Blend 100 mL (1/2 cup) of canned corn, 1 mL (1/8 tsp.) of table salt, and 200 mL (1 cup) of cold water into a blender for 15-20 seconds.

2. Slowly pour the corn soup from the blender into a metal strainer positioned over a plastic cup. Make sure you allow all of the soupy mixture to drop the liquid portion into the cup. Slowly add 30 mL (2 tbsp.) of liquid detergent into the mixture and gently swirl the cup (do this slowly that you do not form bubbles). Let this mixture sit for 5-10 minutes. Gently pour this mixture into test tubes until they are about a third full.

3. Add a pinch of enzymes (meat tenderizer) into each test tube and stir gently. If you stir too hard, you will break up the DNA.





4. Tilt the test tube slowly and pour ice cold rubbing alcohol (70-95% isopropyl or ethanol) down the side of the test tube. You can use a disposable dropper pipet to slowly add the alcohol. You will add enough alcohol so that you have about a 1-in. layer of alcohol on top of the mixture. Let this tube sit for 5-10 minutes.

5. The DNA will begin appearing at the alcohol and water interface layer. You can use a disposable dropper pipet to gently collect the precipitated DNA. You can save the DNA by transferring it to a small container of alcohol (micro-centrifuge tube).

Lesson Extension

As an extension to this lab, repeat the procedure for lab but after completing part 3, you will need to attempt to answer the following questions.

- What was the purpose of using liquid detergent (soap) in the procedure?
- What did the salt and meat tenderizer do to the mixture?
- Why was cold alcohol used in the procedure?
- What do you think caused the DNA to have a white appearance?

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Teacher Resources
Visit www.kansascornstem.com for additional resources and teacher tips.

Lab Analysis
Let students discuss their ideas, and guide the discussion without telling them if they are right or wrong.

- Why didn't we get a large quantity of DNA from corn using our procedure?
- Why is ice-cold alcohol used in our procedure?
- What are nucleases? What do they do?
- How much DNA should we be able to get from canned corn?

Science and Agriculture Careers
To learn more about agriculture careers, visit agexplorer.com. You can also find career profiles at www.kansascornstem.com.

Sources:
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National Research Council (2005). How Students Learn: History, Mathematics, and Science in the Classroom. Committee on How People Learn, A Targeted Report for Teachers, M.S. Donovan and J.D. Bransford, Editors. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Argument-Driven Inquiry in Biology: Lab Investigations for Grades 9-12
By: Victor Sampson, Patrick Enderle, Leeanne Gleim, Jonathon Grooms, Melanie Hester, Sherry Southerland, and Kristin Wilson

Any educator electing to perform demonstrations is expected to follow *NSTA Minimum Safety Practices and Regulations for Demonstrations, Experiments, and Workshops*, which are available at http://static.nsta.org/pdfs/MinimumSafetyPracticesAndRegulations.pdf, as well as all school policies and rules and all state and federal laws, regulations, codes and professional standards. Educators are under a duty of care to make laboratories and demonstrations in and out of the classroom as safe as possible. If in doubt, do not perform the demonstrations.