6.4 - Genetic Modification Mini-Unit

Score
□ Above & Beyond
□ Meets Expectations
□ Near Expectations
□ Incomplete – *fix the following pages:*

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: How are genes modified?

Anchoring Phenomenon: DNA controls an organism's traits by determining the proteins it produces. Scientists can add new genes to cells of organisms. How is a new gene added to a cell, and why do genes from one species function in cells of another species?

Deeper Questions

1. Why do genes from one species work in another species' cells?
2. How are genes removed and inserted into new genomes?
3. How is CRISPR-Cas9 different from other genetic modifications?

Schedule

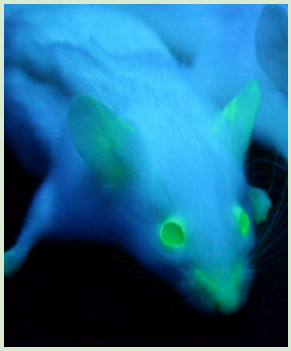
Part 1: Introduction
- Initial Ideas & Data Dive - Bt Corn
- Discussion & Developing Explanations

Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

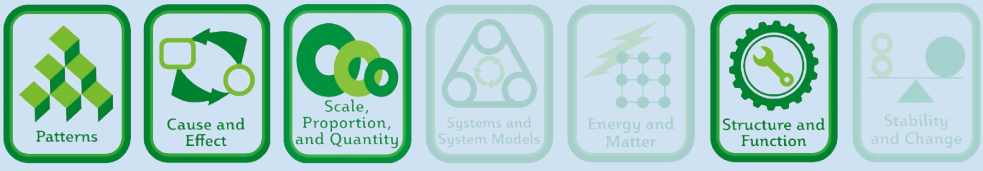
Part 3: Investigation
- Sticky Ends Simulation
- CRISPR Simulation

Part 4: Review & Assessment
- Ranking Your Readiness
- Formative Assessment & Mastery Check

Part 5: Life Connections
- GMO Pro/Con



NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
HS-LS1-1 - How the structure of DNA determines the structure of proteins and function.
HS-LS1-2 - How inheritable variations result from 1) changes via meiosis; 2) errors during replication; 3) mutations via environmental factors HS-LS1-4: How mitosis and differentiation enable complex organisms.



Semester Schedule

5. Traits & Genes
5.1: What determines the traits of an organism?
5.2: How are traits inherited from parents?
5.3: Can we predict traits?
5.4: Unit Assessment

6. DNA & Proteins
6.1: What is DNA and how does it work?
6.2: How does DNA affect protein assembly?
6.3: Unit Assessment
6.4: How are genes modified? *(mini-unit)*

7. Mutations & Change
7.1: How does a protein get its shape & function?
7.2: How do mutations change genes & proteins?
7.3: How can mutations create new traits & species?
7.4: Unit Assessment
7.5: How Does Antibiotic Resistance Occur?

8. Biodiversity
8.1: How does biodiversity affect ecosystems? Why is biodiversity being lost?

These materials were partly developed with assistance from artificial intelligence.

Resource Links: Class Website; Core Ideas; Practice Test; Video Quiz; Intro Video; Restriction Enzyme Video; Sticky Ends JPEG;

Part 1: Introduction – Bt Corn (6.4.1)

Overview: Discuss your initial ideas about genetic modification. Then use data to develop initial explanations.

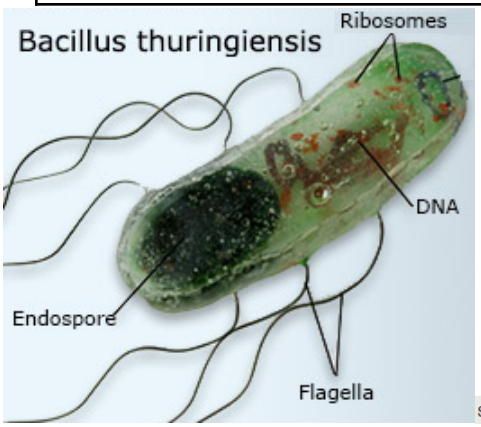
Initial Ideas - *Record your ideas separately (scratch paper, etc.).* *SEP: Engaging in Argument from Evidence*

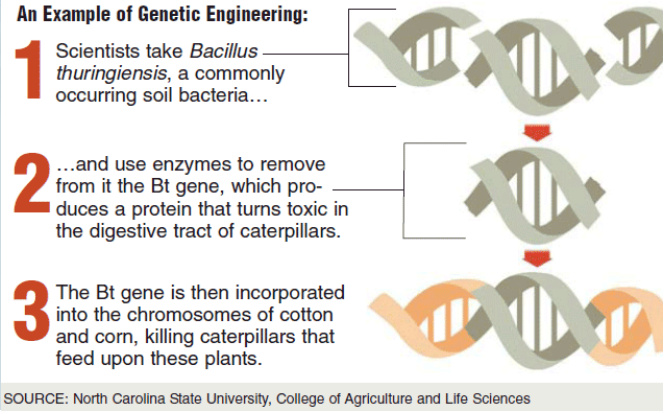
1. Daryll visits his family's farm where his uncle plans to plant corn that produces its own insecticide, reducing the need for harmful pesticides. To create this, scientists added a bacterial gene to the corn's cells. Daryll is intrigued and discusses it with his friends later. **Do you agree or disagree with each student's claim?**
   - Daryll: "I think he is mistaken. The DNA of bacteria must be very different from the DNA of corn, so how could it work in the cells of corn?" *Agree/ Disagree*
   - Avery: "Maybe bacteria and corn make proteins in the same way as each other?" *Agree / Disagree*
   - Chandra: "I've heard that every organism has the same stuff in their DNA, so it would make sense that DNA from one species would work in another species." *Agree / Disagree*

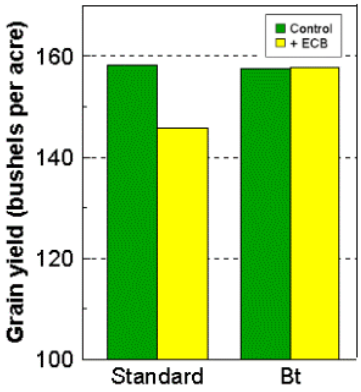
2. Discuss your group's ideas. How are your ideas similar or different? Be prepared to present your ideas.

Data Dive - *SEP: Obtaining, Evaluating, and Communicating Information; Engaging in Argument from Evidence*

In this data dive, you will make observations about how Bt corn was created using four images.
Top left: This image shows the species of bacteria that naturally produces a protein that works as an *insecticide* (a substance that kills insects). (Source)
Top center: This image summarizes how Bt corn was created. (Source)
Top right: This image shows the difference in corn yields between the standard corn and Bt corn under two conditions: control (*no harmful insects*) vs. presence of the European Corn Borer (ECB) caterpillar, a harmful insect. (Source)
Bottom: This image shows a close-up of how genes are cut by enzymes so that they can be inserted into the DNA of a different species. (Source)







Data Dive Questions - *SEP: Engaging in Argument from Evidence (Photo credit: C. Kohn - Milw. Public Museum)*

1. **Begin by individually attempting to make sense of this information**. What trends or patterns do you notice? How does this relate to any prior knowledge or experience that you have?
2. **Next, work in your teams to discuss your ideas**. Where do you agree? Where do you disagree? Can you use this data to reach an agreement? Do others have prior knowledge/experience that could help?
3. **What is one conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?
4. **What is a second conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?
5. **Does this data support or refute any of the initial claims on the previous page?** If so, explain.

Discussion - *Record your ideas in the spaces below.* *SEP: Asking Questions & Defining Problems*

We generally agree that…	***We disagreed or were unsure if…***

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Designing Solutions*

How can genes be moved to different species? Write down an initial explanation below. Don't worry if you aren't completely sure about this. You will revise this explanation as you gain more information.

_____

_____

Part 2: Core Ideas (6.4.2)

Overview: In this activity, you will use an intro video and a short presentation to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. Explain how the following are similar and different: genetic engineering, genome, GMO.
2. How do the cells of a genetically modified organism know how to produce proteins using the new gene?
3. How are most genetically modified organisms created? In your response, include the following: restriction enzyme, restriction site, sticky ends.
4. Is it likely that you will encounter GMOs in your day to day life? Explain using examples.
5. How does CRISPR-Cas9 enable genetic modification? How is it different from earlier forms of genetic engineering?
6. Summarize the three main components of CRISPR-Cas9 and describe their function.

Revising Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Developing Solutions*

How can genes be moved to different species? Based on this new info, how would you now respond?

_____

_____

_____

Use this space for notes if needed.

Part 3A Investigation: Sticky Ends Simulation

Overview: you will use paper models to explore how genes can be moved to new species.

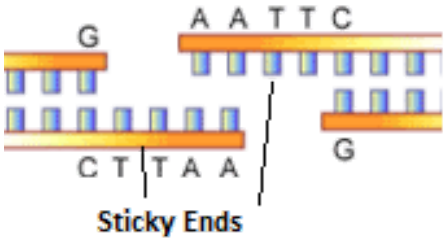
Background: Restriction enzymes are proteins that can cut DNA at specific locations. Some restriction enzymes cut DNA in a way that creates fragments with "sticky ends". Sticky ends are single-stranded portions of DNA that 'stick out' from the strand. Two sticky ends will bind to each other if they have complementary bases (e.g., AATT will bind to TTAA).

To move a gene from one species to another, scientists use the same restriction enzyme to cut both the gene and the new species' DNA. The gene and the other species' DNA will have matching sticking ends, enabling the gene to insert itself into the new genome.

You will be simulating this process using the instructions on the next page.

Directions

1. First, use a pen or pencil to mark the gene and the genome for how and where the *EcoRI* restriction enzymes would cut DNA. Remember that *EcoRI* cuts DNA any time it encounters the letters GAATTC. Use the image below as a guide.

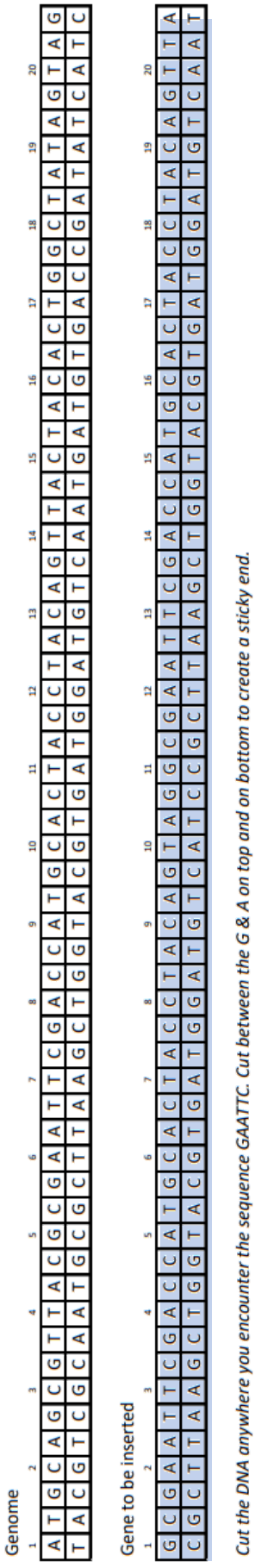


2. Next, use a scissors to cut out the right side of this page along the dotted line.
3. Third, cut out the gene and the genome.
4. Fourth, cut the gene and genome anywhere you find the GAATTC sequence. IMPORTANT: cut the DNA at these sites to produce sticky ends like you see in the image above. You will cut the DNA in <u>three</u> places.
5. Fifth, prepare to use your paper models to demonstrate to your instructor how restriction enzymes and sticky ends enable new genes to be inserted into a species' DNA. Take time to prepare and rehearse how you will demonstrate this. Use the 6.4 Core Ideas to review if needed. Be prepared to answer the following questions:
    a. *What is a sticky end? Why is it called that?*
    b. *What is a restriction enzyme? What does it do?*
    c. *How do restriction enzymes and sticky ends make genetic engineering possible?*
    d. *How would a cell know how to use the inserted gene to produce a protein? How would this change its traits?*
6. When you think you are ready to explain this process, **<u>raise your hand</u>**. Your instructor will listen to your explanation.

This activity was successfully completed

_____

(*instructor signature*)



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Part 3B: CRISPR-Cas9 Simulation

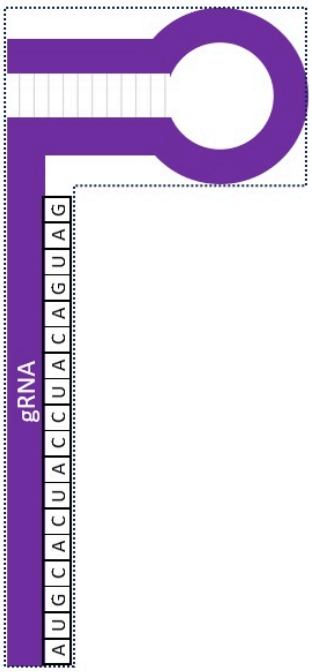
Overview: You will use paper models to explore how CRISPR-Cas9 can modify genes.

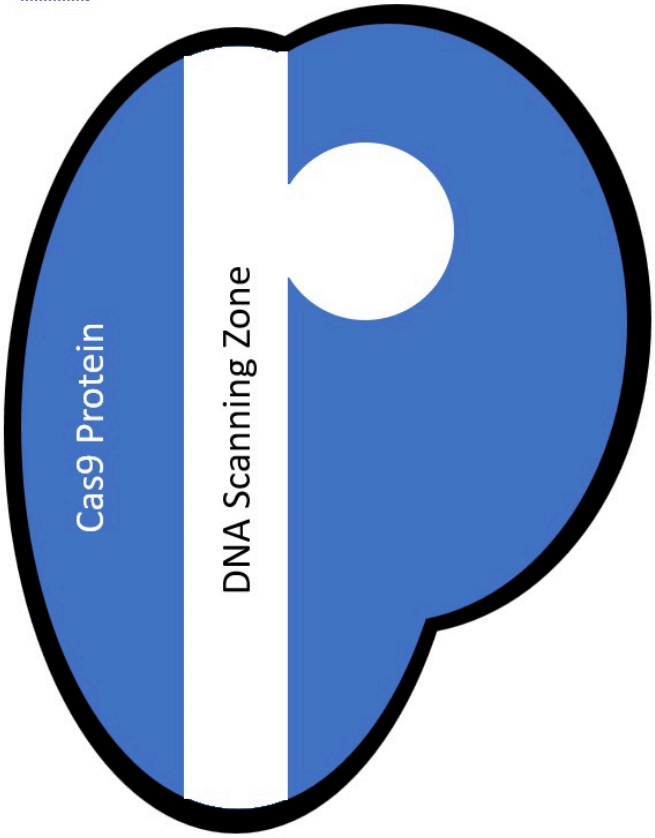
Directions: *Carefully read the directions below before beginning.*

1. ☐ Use a scissors to cut off the right half of this page. Then cut out each of the following: A) Cas9 protein; B) gRNA (cut along the dotted line); C) DNA segment.
2. ☐ Use a small piece of tape to secure the rounded part of the gRNA to the Cas9 protein.
3. ☐ Insert one of segment of DNA between the Cas9 protein and gRNA in the space labeled "DNA Scanning Zone."
4. ☐ If you discover a segment of the DNA that is complementary the gRNA, highlight it with a different color.
5. ☐ Prepare to use your paper models to demonstrate how CRISPR-Cas9 functions. Be prepared to answer the following questions. Use the 6.4 Core Ideas to review if needed:
   a. What is the role of each of the following? A) CRISPR; B) Cas9; C) gRNA.
   b. What occurs if CRISPR-Cas9 encounters DNA that is complementary to its gRNA sequence?
   c. How is CRISPR-Cas9 different from using restriction enzymes to modify DNA?
6. ☐ When you are ready to explain these concepts using your paper model, **raise your hand**. Your instructor will listen to your verbal responses and check your work.

This activity was completed _____

(*instructor signature*)





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Part 4: Review & Assessment (6.4.4)

Step 1: Rank each Driving Question in Part 2 based on your comprehension (you can rank them as *1,2,3* or *green/yellow/red*, or any other method). Then work in teams to review anything that is still unclear.
Step 2: Identify any remaining areas of confusion or concern. Then review these topics with your instructor.
Step 3: Complete the Formative Assessment (*last page of the packet*). Your instructor will determine if you will work individually, in pairs, or in small groups. Then compare and evaluate your responses as a class.
Step 4: Individually complete a Mastery Check. If your performance indicates that additional support is needed, your instructor will determine how to help you move forward.

Part 5: Life Connections – GMO Pro/Con

Overview: For this activity, you will work in teams to debate the benefits and drawbacks of using genetically modified organisms, particularly in regard to food production.

Directions:

1. Begin by visiting https://www.procon.org/headlines/gmos-top-3-pros-and-cons/ (or type "GMOs – Top 3 Pros and Cons" into an internet search engine).
2. Begin by reading the overview section on GMOs at the top of the page. Work with your team to make sure everyone understands the key points of this reading.
3. Complete the table on the next page by summarizing the information on the website.
4. As a group, try to achieve a consensus on GMOs. What is your stance, and what evidence supports your stance? Record your final ideas below. Be prepared to discuss your ideas.
5. Determine whether this is a credible source for this topic and justify your stance with evidence and reasoning. Be prepared to discuss your ideas.

What is your stance on GMOs?_____

_____

_____

Why is this your stance? What reasoning or evidence supports this? _____

_____

_____

_____

Should Genetically Modified Organisms (GMOs) Be Grown?		
Pro 1		Con 1
Key Evidence		Key Evidence
Pro 2		Con 2
Key Evidence		Key Evidence
Pro 3		Con 3
Key Evidence		Key Evidence

Genetic Modification Mini-Unit Formative Assessment

Name: _____ Hour_____ Date:_____ Score:_____ /_____

Directions: A 3x5 notecard with handwritten notes can be used to guide your answers. Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist.

Scientists have created genetically modified goats that produce spider silk proteins in their milk. These proteins can be used to create exceptionally strong materials. To accomplish this, they moved a gene from the spider genome to the goat's genome.

1. **What is the difference between genetic engineering and a genetically modified organism (GMO)?** Include the terms *gene* and *genome* in your response.

Writer's Name:

2. **How did restriction enzymes and "sticky ends" enable scientists to move a gene from the genome of a spider to the genome of a goat?**

Writer's Name:

3. **How would a goat's cell know how to read and use a gene from a spider?**

Writer's Name:

4. The behavior and physical appearance of 'spider goats' is identical to any other goat. **If these goats have a spider gene added to their genome, why don't they have eight legs, spin webs, etc.?**

Writer's Name:

5. Spider goats were developed prior to the discovery of CRISPR-Cas9. **How does CRISPR-Cas9 differ from the older forms of genetic engineering?**

Writer's Name:

6. GMOs can be a controversial topic. What is your stance on this issue? **Do you think it is ok to move genes from one species to another? Why or why not? Explain your reasoning.**

Writer's Name:

