

7.2 - Mutations & Change Unit, Packet 2

Score
<input type="checkbox"/> Above & Beyond
<input type="checkbox"/> Meets Expectations
<input type="checkbox"/> Near Expectations
<input type="checkbox"/> Incomplete – <i>fix the following pages:</i>

First & Last Name: _____ Period/Hour: _____

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

<p>Driving Question: How do mutations change genes & proteins?</p>	
<p>Anchoring Phenomenon: We'll deepen our understanding of mutations by exploring how mutations occur, causes of mutations, and how different kinds of mutations affect proteins and the traits. We'll begin with the example of double-muscling cattle, which have excess muscle due to a mutation.</p>	
<p>Deeper Questions</p> <ol style="list-style-type: none"> 1. What kinds of mutations can occur? 2. Why do mutations occur? 3. What are the impacts of different kinds of mutations? 	
<p>Schedule</p>	
<p>Part 1: Introduction</p> <ul style="list-style-type: none"> - Initial Ideas & Data Dive - Double-Muscling - Discussion & Developing Explanations <p>Part 2: Core Ideas</p> <ul style="list-style-type: none"> - Core Ideas - Revisions of Part 1 Explanations <p>Part 3: Investigation</p> <ul style="list-style-type: none"> - Mutation Simulation <p>Part 4: Review & Assessment</p> <ul style="list-style-type: none"> - Ranking Your Readiness - Formative Assessment & Mastery Check <p>Part 5: Life Connections</p> <ul style="list-style-type: none"> - Genetic Diseases 	<p><i>Original Sequence</i></p> <p><i>Deletion Frameshift</i></p> <p><i>Insertion Frameshift</i></p>
<p>NGSS Standards (<i>PEs & CCCs are summarized below. SEPs are noted throughout the packet.</i>)</p> <p>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-LS4-3 – How organisms with advantageous traits increase in proportion in their populations. HS-LS4-4 - How natural selection leads to adaptations of populations. HS-LS4-2 - Evolution is due to 4 factors: 1) reproduction; 2) heritable mutations; 3) competition; 4) enhanced survival & reproduction in comparison to individuals without beneficial mutations.</p>	
<p>Resource Links: Class Website; Core Ideas; Video Quiz; Summary Video; Mutation Simulation (Part 3); Mutation Simulation How-To Video; SciToons Mutation Video;</p>	

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.

Part 1: Introduction – Double Muscle Cattle (7.2.1)

Overview: Discuss your initial ideas about how mutations occur. Then use data to develop initial explanations.

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

- Mutations are changes that occur in a gene for a protein. Altering the DNA can change the way in which proteins are assembled. This can change the shape of the protein, potentially impairing its function. Three students shared their ideas about why mutations occur. **Do you agree or disagree with each student's claim?**
 - Mike: "I think that mutations occur because of errors that happen when DNA is duplicated during mitosis or meiosis." *Agree / Disagree*
 - Lucia: "I think that mutations occur because of factors outside of the body. For example, I know that too much sunlight or eating too much processed food can be problematic." *Agree / Disagree*
 - Oscar: "I think that mutations result from errors that occur during transcription or translation." *Agree / Disagree*
- Discuss your group's ideas. How are your ideas similar or different? Be prepared to present your ideas.

Data Dive - Watch this [video](#) and then complete the reading below. Use the space on the right to annotate the text by recording your ideas, highlighting important points, and recording questions as you are reading. SEP: Obtaining, Evaluating, and Communicating Information

"Double muscling" is caused when the *myostatin* gene is mutated. This changes the *myostatin* protein, which regulates and limits muscle growth. Animals with a myostatin mutation have 2-3 times more muscle fibers.

While more muscle might seem valuable for animals used for meat, these animals can be born so big that they need surgery to be born safely. Animals with this mutation can also have trouble eating due to thicker tongues. Also, their meat is lower in quality because it has less fat than normal meat.

Two breeds of cattle are more likely to have the double-muscling mutation: the Piedmontese and Belgian Blue. In Piedmontese cattle, one base is changed, causing it to code for a cysteine amino acid instead of tyrosine.

Belgian Blue cattle can inherit a myostatin gene missing 11 bases due to errors from crossing over. This shifts the remaining bases, changing all the codons after the mutation. This changes the amino acids in the rest of the protein, changing large portions of the myostatin protein.

In both cases, these mutations change how the myostatin protein is assembled. This changes its shape and impairs its function. The mutated myostatin protein cannot properly regulate and limit muscle growth, leading to more muscular animals.



(Image Sources – Top: [Popsci](#); Bottom: [Pixabay](#))

Driving Question:

1. What is "double muscling"? What causes this condition?
2. What does the myostatin protein do? Why would a mutation to this gene affect an animal's muscle growth?
3. Is this mutation good or bad?
4. What mutation causes this condition in Piedmontese cattle?
5. What mutation causes this condition in Belgian Blue cattle?
6. The first kind of mutation only changes one amino acid. The second mutation changes a long chain of amino acids. Why is there a difference?

Data Dive Questions - SEP: Engaging in Argument from Evidence

1. How do cells assemble proteins during transcription and translation? How do amino acid properties affect protein shape and function? How do proteins affect an organism's traits?
2. What does the myostatin protein do? How would a mutation in the myostatin change the traits of cattle?
3. In some cases, the myostatin gene is changed so that the amino acid tyrosine is replaced by cysteine. What is different about the amino acid cysteine? Predict how this change would affect the protein.
4. In Belgian Blue cattle, 11 nucleotides are missing from the genes of most affected animals. This changes every codon after this mutation. How would this change the amino acid sequence?
5. Which seems like it would affect a protein more, a) substituting one base for another base, or b) inserting or deleting bases from a gene? Explain your reasoning and support it with evidence.
6. This article summarizes two different kinds of mutations. What do you think is responsible for these different kinds of mutations? What might cause substitution, deletion, or insertion of bases in a gene?

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 do mutations change genes & proteins? 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 (7.2.2)

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

- | | |
|---|---|
| <ol style="list-style-type: none">1. What is a mutation?2. What is the difference between an acquired mutation and a hereditary mutation?3. How were the thalidomide case studies an example of acquired mutations? How are double muscle cattle examples of hereditary mutations?4. What are the causes of hereditary and acquired mutations? What factors cause changes to DNA?5. What are mutagens? What are examples of mutagens? | <ol style="list-style-type: none">6. What is the difference between a substitution mutation and a frameshift mutation?7. What are two causes of frameshift mutations?8. Why do frameshift mutations tend to have more impact than substitution mutations?9. What is a chromosomal mutation? How is this different from other kinds of mutations?10. What are four ways in which chromosomal mutations can occur?11. How is Down's syndrome an example of a chromosomal mutation? |
|---|---|

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

How do mutations change genes & proteins? Based on this new info, how would you now respond?

Use this space for notes if needed.

Part 3 Investigation: Mutation Simulation (7.2.3)

Overview: In this investigation, you will use a computer simulation to investigate different kinds of mutations.

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are all ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*

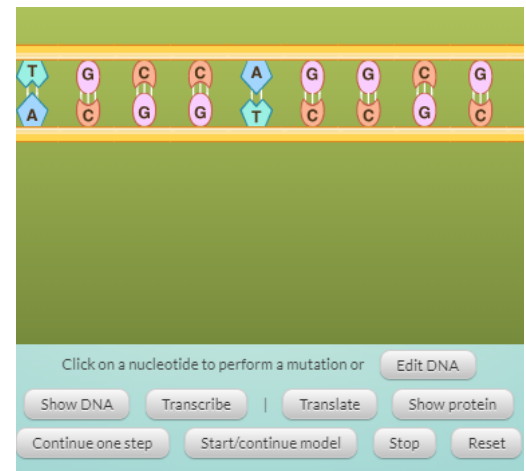
SEP: Developing & Using Models

1. What is the difference between acquired and hereditary mutations?
2. What is the difference between substitution mutations and frameshift mutations?
3. What are potential causes of mutations?
4. Why do some mutations change proteins and traits more than others?

This activity was completed _____ (instructor signature)

Methods: Check each box as you complete each step.

1. First, access this program on an approved device by clicking [here](#) (or use a search engine to search for *DNA Mutation Simulation LabXchange*). Your screen should resemble this
2. Second, click the “Transcribe” button to see a simulation of how RNA polymerase creates the mRNA copy of a gene.
 - a. Then click the “Translate” button to see how the protein is assembled using the mRNA copy.
 - b. Finally, click “Show Protein” to see the product.
 - c. Observe the amino acids in this protein. Notice how they are color-coded. Use the table on the next page to determine what these colors indicate. Record this below.
3. Next, click “Reset” and then “Edit DNA”. Change the DNA to reflect how a substitution mutation would occur. Repeat the steps above. Record your observations on the next page.
4. Next, click “Reset” and then “Edit DNA”. Change the DNA to reflect how a frameshift mutation would occur due to a deletion. Repeat the steps above. Record your observations on the next page.
5. Finally, click “Reset” and then “Edit DNA”. Change the DNA to reflect how a frameshift mutation would occur due to an insertion. Repeat the steps above. Record your observations on the next page.



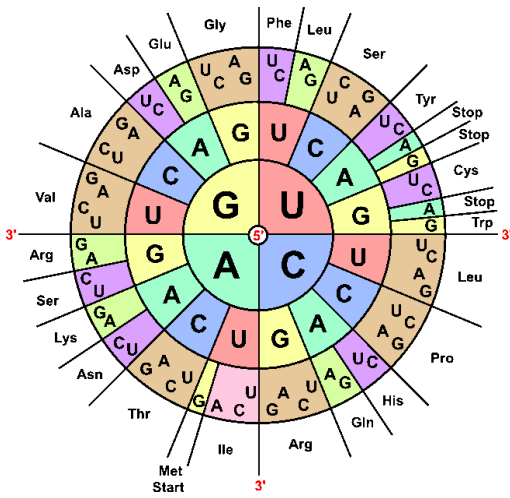
Investigation Questions:

1. The original gene was: ATGCCAGGCGGCGAGAGCTTGCTAATTGGCTTATAG
What was the amino acid sequence that was produced in response to this sequence?

Met _____

2. The amino acids were color-coded by this program. **What did these colors represent?**

Hint: use the codon wheel and amino acid table on the next page to assist you with these questions.



Amino Acid	Charge	Hydrophobicity
alanine - ala	Neutral	Hydrophobic
arginine - arg	Positive	Hydrophilic
asparagine - asn	Neutral	Hydrophilic
aspartic acid - asp	Negative	Hydrophilic
cysteine - cys	Neutral	Hydrophilic
glutamine - gln	Positive	Hydrophilic
glutamic acid - glu	Negative	Hydrophilic
glycine - gly	Neutral	Hydrophobic
histidine - his	Positive	Hydrophilic
isoleucine - ile	Neutral	Hydrophobic

Amino Acid	Charge	Hydrophobicity
leucine - leu	Neutral	Hydrophobic
lysine - lys	Positive	Hydrophilic
methionine - met	Neutral	Hydrophobic
phenylalanine - phe	Neutral	Hydrophobic
proline - pro	Neutral	Hydrophobic
serine - ser	Neutral	Hydrophilic
threonine - thr	Neutral	Hydrophilic
tryptophan - trp	Neutral	Hydrophobic
tyrosine - tyr	Neutral	Hydrophobic
valine - val	Neutral	Hydrophobic

3. How did you change the original DNA sequence to reflect a substitution mutation? Cross out the base that was substituted and write its replacement using the sequence below:

ATGCCAGGCGGCGAGAGCTTGCTAATTGGCTTATAG

4. What was the amino acid sequence that was produced in response to this sequence?

5. How did you change the original DNA sequence to reflect a frameshift mutation due to a deletion? Cross out the base that was deleted using the sequence below:

ATGCCAGGCGGCGAGAGCTTGCTAATTGGCTTATAG

6. What was the amino acid sequence that was produced in response to this sequence?

7. How did you change the original DNA sequence to reflect a frameshift mutation due to an insertion? Show the base you inserted using the sequence below:

ATGCCAGGCGGCGAGAGCTTGCTAATTGGCTTATAG

8. What was the amino acid sequence that was produced in response to this sequence?

9. While frameshift mutations generally change proteins more than substitution mutations, there are exceptions. Using the same program, edit the original DNA to reflect the change below.

ATGCCAGGCGGCGAGAGCTTGCTAATTGGCTTATAG
 ATGCCAGGCGGCTIAGAGCTTGCTAATTGGCTTATAG

How did this change the amino acid sequence? Why did this minor change result in this outcome?

Be prepared to discuss and defend your ideas in small groups and as a class.

Part 4: Review & Assessment (7.2.4)

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 – Genetic Diseases (7.2.5)

Directions: Use the directions below to obtain more information about a specific genetic disease using an internet search engine.

1. Visit the following website: <https://www.genome.gov/For-Patients-and-Families/Genetic-Disorders> (or type “Genetic Disorders” and “NIH” into an internet search engine to find the article).
2. Skim through the list of genetic disorders. With a partner or group, choose a disorder to focus on.
 - a. Your instructor may require each group to choose a different disorder. Follow their instructions.
3. With your group, use this resource to address the following:
 - a. Summarize this disease. What does it involve? How does it affect the body?
 - b. What are the symptoms of this disease?
 - c. What causes this disease? How is this a genetic disease? Is there a specific mutation?
 - d. How is this disease diagnosed?
4. Use an internet search engine to find another source that provides information about this disease. Address *each* of the following in this [Google doc](https://forms.gle/HQchByVL5oEbR4qT8): <https://forms.gle/HQchByVL5oEbR4qT8>
 - a. **Credibility:** Who is the author? What are their credentials? Are they sufficiently qualified to provide this kind of information? Who is sponsoring or publishing this information?
 - b. **Accuracy:** Does this information seem accurate based on what you already know about this topic? Do you have any reason to be concerned about accuracy in this source?
 - c. **Reliability:** Does the website present a certain bias or viewpoint?
 - d. **Relevance:** Does this website sufficiently enable you to address your questions about this topic?
 - e. **Date:** When was this information published? Is it still relevant, or is it potentially out of date?
 - f. **Sources:** Does the author cite their sources? Are their sources credible?
 - g. **Overall:** Based on your responses, do you think this is a good source to use for you research?
5. Be prepared to discuss your group’s findings in a class discussion. Choose a spokesperson for each consideration.

WHEN Mutations Occur

When do acquired mutations occur?

Where are acquired mutations found?

Can acquired mutations be passed on?

When do hereditary mutations occur?

Where are hereditary mutations found?

Can hereditary mutations be passed on?

WHY Mutations Occur

How can polymerase and DNA duplication affect mutations?

What are mutagens and how do they affect mutations?

How can crossing over relate to mutations?

Which kinds of mutations can result from crossing over errors?

WHAT Kinds of Mutations Occur

What do you need to know about substitution mutations?

What do you need to know about frameshift mutations?



Mutations & Change Unit - Packet 7.2 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.

1. **What is a mutation? How do mutations in DNA affect proteins and traits?**

Writer's Name:

2. Three students shared their ideas about why mutations occur. **Do you agree or disagree with each student's claim?**

- a. Mike: "I think that mutations occur because of errors that happen when DNA is duplicated during mitosis or meiosis." Agree/ Disagree
- b. Lucia: "I think that mutations occur because of factors outside of the body. Like, I know that too much sunlight or eating too much processed food can be problematic." Agree / Disagree
- c. Oscar: "I think that mutations result from errors that occur during transcription or translation, particularly when DNA is being copied into mRNA." Agree / Disagree

3. **Which claim(s) is/are most accurate? _____ Why? _____**

Writer's Name:

4. **What is the difference between an acquired mutation and a hereditary mutation?**

Writer's Name:



5. Summarize the difference between substitution and frameshift mutations. Then explain how these different mechanisms for mutations affect codons, amino acids, and protein assembly differently.

Writer's Name:

6. Birth defects due to thalidomide, double muscle cattle, and Down's syndrome were all examples used to illustrate the effects of mutations. Briefly summarize the cause of each example and explain how each respective kind of mutation resulted in these outcomes.

Thalidomide:

Double-Muscling:

Down's Syndrome:

Writer's Name: