A Study of Traits
Lesson 8: The Expression of Traits

Grade: 9-10 General Biology

Length of lesson: 105 minutes

Placement of lesson: Lesson 8 of 9

Unit Overarching Goal

In plants and animals, similarities and differences among individuals within a species result from proteins coded for by the DNA inherited from their parents. Variations among individuals are the result of mutation, meiosis, and recombination through sexual reproduction.

Unit Central Question

What is the best explanation for the similarities and differences we see in individuals within a species—not only for one species, but for every species of plant and animal?

Lesson 8 Main Learning Goal

An individual's traits are determined by the combination of genes they receive from their parents that code for a specific amino acid sequence to make a protein with a specific function.

Lesson 8 Focus Question

How can multiple offspring of the same parents have different versions of the same trait?

Ideal student response

Multiple offspring of the same parents can have different versions of the same trait because they can inherit different combinations of alleles for the gene associated with the trait from their parents. When gametes are made, the pairs of chromosomes separate. If each chromosome has a different allele of a gene, half of the gametes will have one allele and the other half will have the other allele. Offspring inherit one chromosome of each pair (and the alleles on those chromosomes) from each parent. If two alleles have differences in their DNA sequence, they produce proteins with different sequences—and thus proteins with altered structures and functions. Proteins determine the traits, so different proteins result in different traits.

Science Content Storyline

In meiosis, chromosome pairs are separated in the production of eggs and sperm. Chromosomes are then recombined through sexual reproduction. An individual's traits are the result of proteins coded for by the combination of genes they receive from their parents.

Materials

- Chart paper, 2 per table group
- Markers, colored pencils, and/or crayons, 1 set per table group
- Tape to hang charts
- Sticky notes, 3" x 3," 1 pad per table group
- DNA sequences for mosquitos and geese

Advance Preparation

- Determine where table groups will hang their illustrations so that others can see them and leave sticky note feedback on the illustrations easily.
- Cut out the DNA sequences for mosquitos and geese. As groups determine which organism will be the focus of their illustration, provide the correct sequence to each group.

Lesson 8 General Outline

Time (min)	Phase of lesson	How the science content storyline develops
10	**Link to Previous Lesson** The teacher reviews student ideas about chromosomes and meiosis. **Lesson Focus Question**: **How can multiple offspring of the same parents have different versions of the same trait?** The teacher introduces the lesson focus question.	
60	**Inheritance of Traits** <u>Activity Setup</u> Students review the process of gene expression and review the rubric that willbe used to assess their understanding. Students prepare to create a visual representation that summarizes their conceptual model of inheritance and variation of traits. <u>Activity</u> Students create a visual representation of either the inheritance of mosquito resistance to insecticide or high-altitude flying geese using classical Mendelian genetics and molecular models of inheritance. <u>Activity Follow-up</u> Students share their representation and get feedback on their representation and science ideas and then revise their representation.	In meiosis, chromosome pairs are separated in the production of eggs and sperm. Chromosomes are then recombined through sexual reproduction. An individual's traits are the result of proteins coded for by the combination of genes they receive from their parents.
30	**Synthesize and Summarize** In table groups, students use the Explanation Tool to develop a scientific explanation that answers the question: how is it possible that multiple offspring of the same parents can have different traits?	
5	**Summarize and Link to Next Lesson** The teacher and students summarize the lesson and link to the next lesson.	

Lesson 8: Inheritance of Traits

Phase of Lesson: *Link to Previous Lesson and Lesson Focus Question: How can a protein determine the traits, and versions of a trait, of an individual organism?*

Main Learning Goal: An individual's traits are determined by the combination of genes they receive from their parents that code for a specific amino acid sequence to make a protein with a specific function.

Focus Question: How can multiple offspring of the same parents have different versions of the same trait?

Unit Overarching Goal:

In plants and animals, similarities and differences among individuals within a species result from proteins coded for by the DNA inherited from their parents. Variations among individuals are the result of mutation, meiosis, and recombination through sexual reproduction.

Notes:

Time: 10 Minutes

STeLLA Strategies

- ❖ Strategy 1: Ask questions to elicit student ideas and predictions
- ❖ Strategy 2: Ask questions to probe student ideas and predictions

Science Ideas

- Individual organisms have characteristics that differ from other individuals of the same species.
- The characteristics (different versions of a trait) of an individual organism are the result of the proteins in that organism.
- There are different explanations, including parents, genes, and mutations, for why these variations occur.
- Evidence helps scientists evaluate the strengths and limitations of explanations.

Common Student Ideas

- Genes are traits.
- Each parent contributes genetic information for certain traits and not others (i.e., he has his mother's eyes and father's nose).
- Different cell types (skin, muscle, bone) found in an individual's body contain different DNA.
- Some characteristics of offspring are determined by the parents' environmentally acquired characteristics.
- DNA is made of proteins and/or amino acids.
- Organisms eat protein; they do not make proteins.

Lesson 8: Inheritance of Traits

Introduction

You have learned that an offspring receives two copies of each gene, one from its mother and one from its father. A gene may have several different forms, or alleles. In jaguars, there are two alleles for the gene that codes for fur color.

You have also learned that an individual's genes determine its traits. Genes code for specific proteins and the structure of that protein determines its function. The traits of an organism are the result of its specific combination of proteins.

In this lesson, you will have an opportunity to use and apply your understanding of these processes to the mosquitos and geese you read about in Lesson 1.

Process and Procedure

Lesson Focus Question

1. Write the focus question for this lesson in the box below. Be prepared to share your ideas with the whole class.

How can multiple offspring of the same parents have different versions of the same trait?

Focus on Student Thinking

- Use appropriate elicit (STeLLA Strategy 1) and probe questions (STeLLA Strategy 2) to reveal student ideas about how offspring of the same parents can have different versions of the same trait.
    - Following are some question you might ask:
        - What are your ideas about how two individuals who have the same parents could have different traits? **(Elicit)**
        - Say more about how they could get different genes. **(Probe)**
        - So, you are saying that offspring don't necessarily get the same chromosomes. Is that right? **(Probe)**
        - What do you mean when you say they get different ones from mom and dad? **(Probe)**

Implementation	Notes
Link to Previous Unit • Remind students that in the last several lessons they have been learning a lot about genetics and how offspring inherit their traits from their parents. • Share that in this lesson they will synthesize and summarize the science ideas they learned in the last two lessons. Students will use and apply the science ideas they learned while studying jaguar coat color to variations among the mosquitos and geese they read about in the case studies in Lesson 1. *Lesson Focus Question* ● **STEP 1:** Introduce the lesson focus question, "How can multiple offspring of the same parents have different versions of the same trait?" ● Allow time for students to write the focus question in the box in their workbooks. Reassure them that they are just beginning the lesson, so they may not know the answer, but they should think about their best ideas about the question based on their learning from previous lessons. Share that they will have a chance to revise their ideas as they work through the lesson. ● Once students have written the focus question in their workbooks, ask several students to share their ideas with the whole class. This is not a time to challenge their ideas, but rather make their current thinking about the focus question visible through the use of Strategy 1: Ask questions to elicit student ideas and predictions and Strategy 2: Ask questions to probe student ideas and predictions. Use the information in "Focus on Student Thinking" in the SE key to see examples of ways to elicit and probe student ideas.	

Lesson 8: Inheritance of Traits

Phase of Lesson: *Looking for Variation: Differences in Proteins*

Main Learning Goal: An individual's traits are determined by the combination of genes they receive from their parents that code for a specific amino acid sequence to make a protein with a specific function.

Focus Question: How can multiple offspring of the same parents have different versions of the same trait?

Unit Overarching Goal:

In plants and animals, similarities and differences among individuals within a species result from proteins coded for by the DNA inherited from their parents. Variations among individuals are the result of mutation, meiosis, and recombination through sexual reproduction.

Notes:

Time: 80 Minutes

STeLLA Strategies

- Strategy 1: Ask questions to elicit student ideas and predictions
- Strategy 2: Ask questions to probe student ideas and predictions
- Strategy 3: Ask questions to challenge student thinking
- Strategy 6: Engage students in developing and using models
- Strategy 8: Engage students in using and applying new science ideas in a variety of ways and contexts
- Strategy G: Link science ideas to other science ideas

Science Ideas

- Proteins are made of amino acids bonded together in a chain.
- If there is a change in the number or order of amino acids due to omission or replacement of amino acids, the overall shape of the protein will change.
- A change in protein structure may cause the protein to function differently.
- The omission and replacement of amino acids in the MC1R protein causes the protein to produce a different type of melanin which results in different coloration.

Common Student Ideas

- Genes are traits.
- Each parent contributes genetic information for certain traits and not others (i.e., he has his mother's eyes and father's nose).
- Different cell types (skin, muscle, bone) found in an individual's body contain different DNA.
- Some characteristics of offspring are determined by the parents' environmentally acquired characteristics.
- DNA is made of proteins and/or amino acids.
- Organisms eat protein; they do not make proteins.

Inheritance of Traits

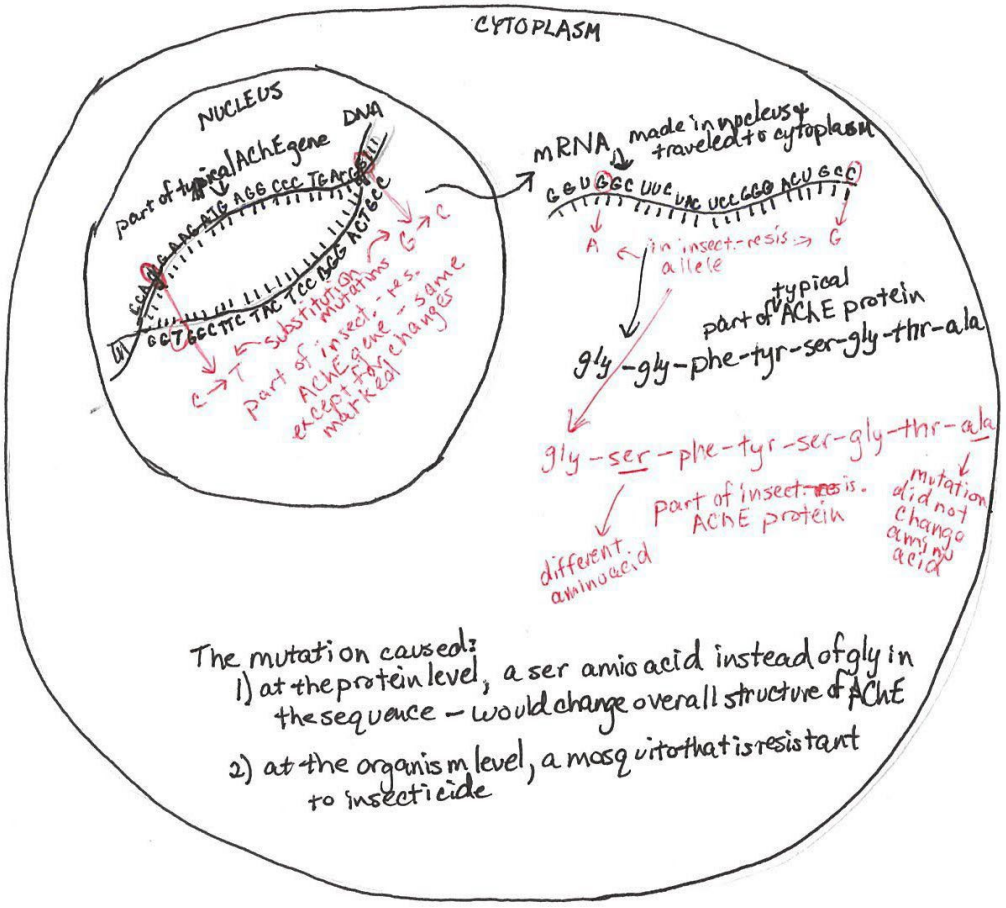
2. As a team, you will create an illustration of gene expression, the process by which the genes an organism inherits from its parents result in a trait. While individuals have two copies of each gene, for your illustration you will use a single gene in your illustration.

   Your illustration should show the following criteria:

   - ❑ The name of the gene and its location in the cell
   - ❑ The DNA sequence for the portion of the gene given
   - ❑ The location and a description of the mutation that occurs, labeled with the type of mutation
   - ❑ The mRNA sequence that is transcribed and its location in the cell
   - ❑ The important components of translation and their locations in the cell
   - ❑ The amino acid sequence that is produced by translation of the mRNA
   - ❑ A description of how the mutation affects the organism at both the protein and organism level

   Note: Your teacher will provide you with copies of the sequences for your organism. You may attach them to your illustration if it is helpful.

   An example illustration is shown.



Implementation	Notes

Activity Setup: Inheritance of Traits
• **STEP 2:** Invite students to read the directions for creating an illustration of the process of gene expression and the illustration rubric. Have students discuss the directions and rubric with their teammates. Ask groups if they have any clarifying questions about the task or the rubric.
  ○ Have table groups select which organism they will develop an illustration for. Remind groups that they can find additional information about each organism in the case study handout from Lesson 1.
  ○ As table groups select their organism, provide each group with the following:
  ▪ The appropriate DNA sequences for their organism.
  ▪ Chart paper
  ▪ Markers, colored pencils, and or crayons	

Resistance to Insecticide in Mosquitoes

Review the mosquito case on the *Variations in Organisms* handout from Lesson 1.

The following sequences show a part of the DNA sequence in the typical AChE allele and the insecticide-resistant AChE allele. Note that this is only a small portion of the DNA sequence. The whole AChE gene is made up of several thousand DNA nucleotides, begins with a start codon, and ends with a stop codon.

Typical AChE:

CGG CGG CAG TAC GAC ACC TAG AAG CCC CCA CCG AAG ATG AGG CCC TGA CGG

Insecticide-resistant AChE:

CGG CGG CAG TAC GAC ACC TAG AAG CCC CCA TCG AAG ATG AGG CCC TGA CGC

Geese Living at High Altitude

Review the geese case on the Variations in Organisms handout from Lesson 1.

The following DNA sequence shows a portion of the alpha hemoglobin gene (HBA) in bar-headed geese that fly at high altitude and in graylag geese, a type of goose that lives at lower altitude. Note that this is only a small portion of the DNA sequence. The whole hemoglobin gene is made up of several thousand DNA nucleotides, begins with a start codon, and ends with a stop codon.

Greylag goose HBA:

CAA CAC CGG TAT GTA GTA GGG AGC CGT AAC TGC GGT CTT CAG GTG CGA TCG

Bar-headed goose HBA:

CAA CAC CGG TAT GTA GTA GGG AGC CGT AAC TGC CGT CTT CAG GTG CGA TCG

Implementation	Notes

Activity: Inheritance of Traits
• Remind students that their illustration is a visual representation of their conceptual model of gene expression. Share that groups will have 45 minutes to complete their illustration. At the end of that time, they should be prepared to share their illustration with the whole class. Provide several time checks throughout the process to help groups with time management.
• As students are working on their models, circulate through the room, asking probe questions to clarify student thinking and challenge questions that help move student thinking forward. In particular note their thinking around common student ideas identified on TE L8-7. Support students as they use and apply science ideas from Lessons 1 – 7 to their organism. Help students explicitly link science ideas to their model. You may also consider feedback that you might include on a sticky note during the gallery walk.
• After 45 minutes, have groups hang their illustration on the wall, grouping the illustrations of like organisms.
• Provide directions for students to complete an uncurated gallery walk, leaving sticky note feedback on the charts. Each student should leave three separate pieces of sticky note feedback. Remind students to use the rubric criteria to leave thoughtful feedback. If needed, define and provide examples and non-examples of productive feedback.
  ○ Non-productive feedback is general or vague and does not help the authors think differently about their work or help them improve their work during a revision process. Examples of non-productive feedback might include, “Your illustration is neat and easy to read,” or “Your illustration is really colorful,” or “It is hard to read your writing.”
  ○ Productive feedback is specific and helps the authors think more deeply about their ideas and improve their work during a revision process. Examples of productive feedback might include, “The parts of the cell are not labeled, so it is not clear where the DNA and amino acids are located in the cell,” or “You described the effect of the mutation on the protein, but not on the organism.”
• As students are providing feedback during the gallery walk, circulate through the room to scan the feedback being provided. If appropriate, add sticky notes with your feedback to the charts.	

Rubric for Gene Expression Illustration

Task	Good	Best
Create an illustration that includes the steps of gene expression.	I created an illustration, but it was missing some of the steps of the process of gene expression.	I created an illustration that includes all steps of the process of gene expression.
Include the name of the gene and its location in the cell.	I drew a representation of the gene, but was not clear about either its structure, location, or name.	I correctly drew a representation for the structure of the gene in the proper location in the cell and labeled it with its name.
Include the location and a description of the mutation that occurs and the name of the type of mutation.	I showed an incorrect mutation or was not clear about the location or type of mutation.	I clearly indicated the mutation and its location and named the type of mutation.
Include the mRNA sequence that is transcribed and its location in the cell.	I showed an mRNA sequence, but there were mistakes in the sequence, or I was not clear about its location in the cell.	I showed a correct mRNA sequence and indicated its location in the cell clearly.
Include the amino acid sequence that is produced by the translation of the mRNA sequence.	I included an amino acid sequence with mistakes in the sequence.	I included a correct amino acid sequence in the cell.
Include a description of how the mutation affects the organism at the protein level and organism level.	I described either the way the mutation affects the protein or the way it affects the organisms.	I described both how the mutation affects the protein and how it affects the organism.
Present the information clearly so that it is easy to understand the illustration.	Most parts of my illustration were clear, but some parts were confusing.	My illustration is clear and includes the correct information, labels, arrows, and brief descriptions where needed.

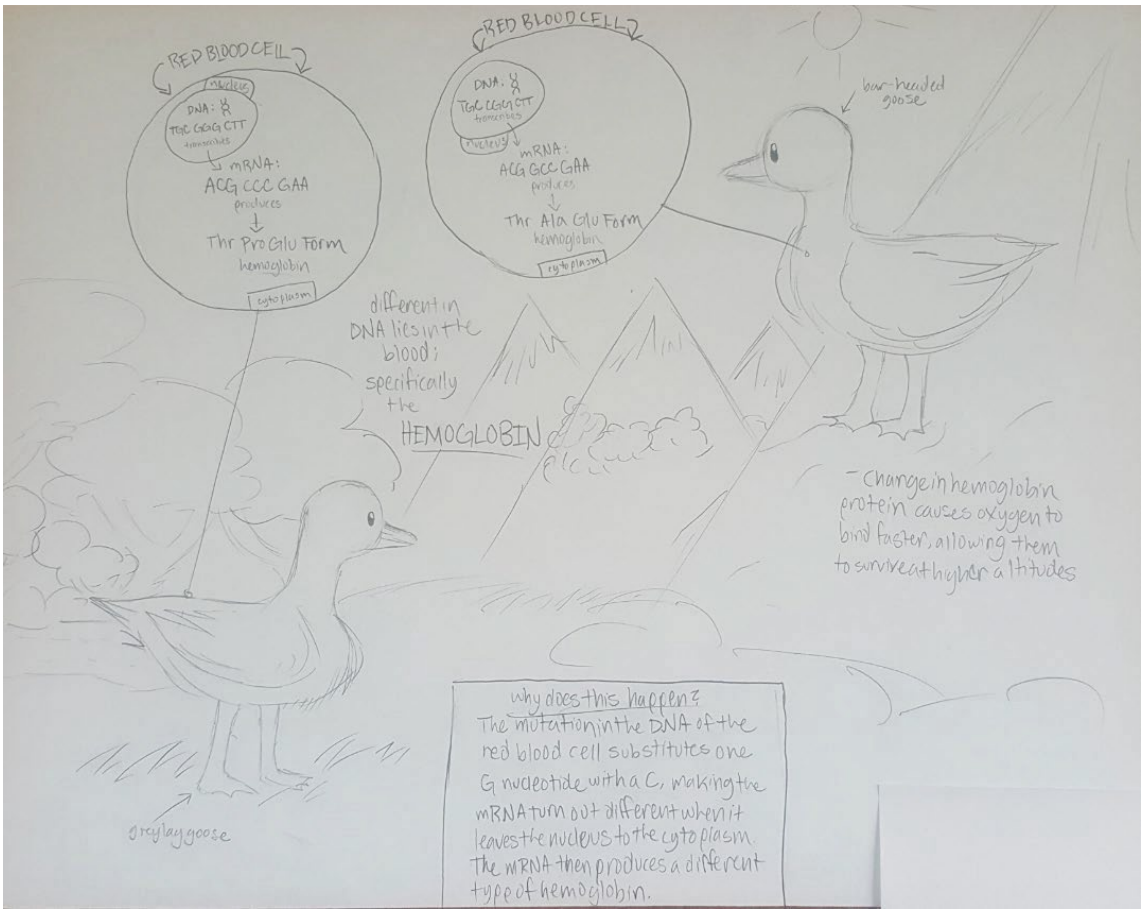
Implementation	Notes

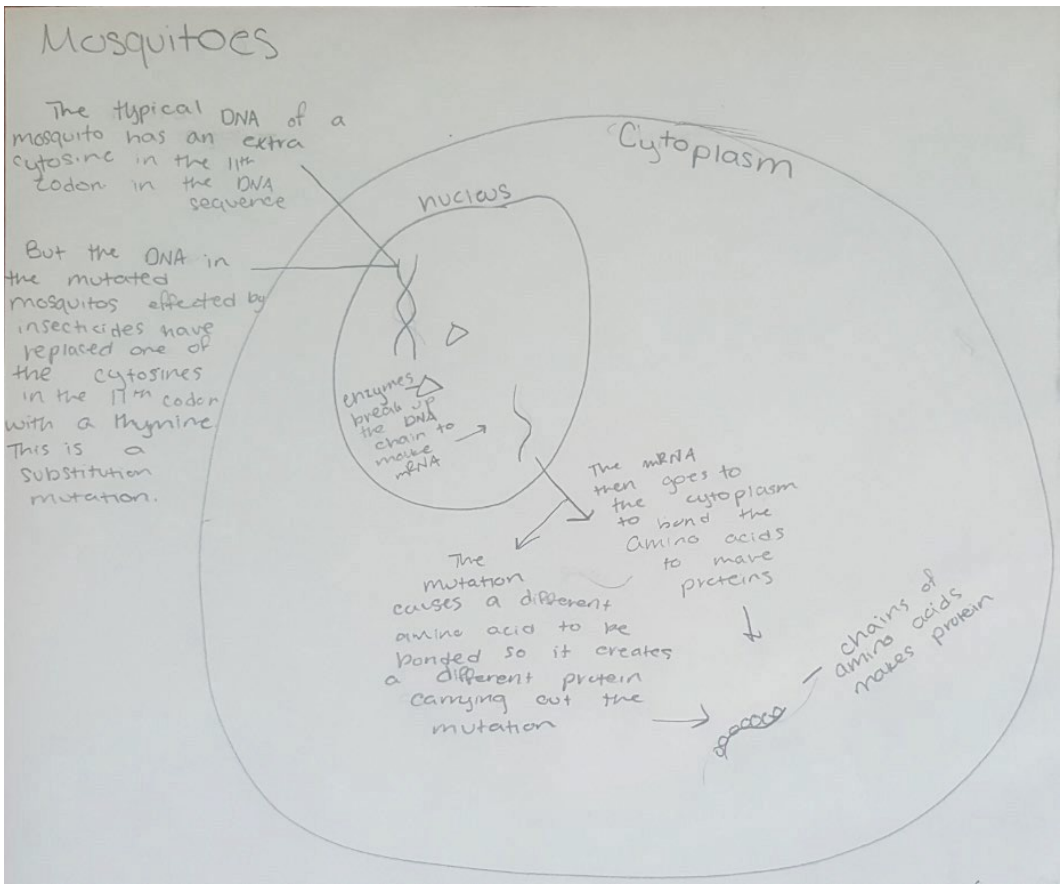
Focus on Student Thinking

- Use appropriate elicit (STeLLA Strategy 1), probe (STeLLA Strategy 2), and challenge (STeLLA Strategy 3) questions to reveal student ideas about gene expression and the effect of mutations.
    - Following are some question you might ask:
        - Tell me about your illustration of gene expression. **(Elicit)**
        - What do you mean by this arrow? **(Probe)**
        - Say more about how translation happens. **(Probe)**
        - What are your thoughts about how a change of one amino acid can change a mosquito from being killed by insecticide to one that is resistant? **(Challenge)**
    - The following is an example of a dialogue that engages students in using their content representations (STeLLA Strategy 6) to explain gene expression and the effect of mutations. Notice how the teacher asks questions that require students to use their diagrams.
        - T: Tell me about your illustration of gene expression. **(Elicit)**
        - S1: Well, here we showed the AChE gene in the nucleus and then it gets transcribed.
        - T: Can you say more about what you mean by "transcribed?" **(Probe)**
        - S1: It's when the DNA gets copied into mRNA.
        - T: Show me on your illustration where that happens. **(A query that asks students to use their content representations)**
        - S1: It's here, in the nucleus.
        - T: Okay, use your illustration to tell me about translation. **(Elicit question that requires students to use their content representations)**
        - S3: It happens here, in the cytoplasm. The mRNA directs the sequence of a protein.
        - T: Say more about how mRNA can direct the sequence of a protein. **(Probe)**
        - S3: Um, the mRNA has codons—three nucleotides in a row—that stand for an amino acid, so it puts the amino acids in the right order for the protein.
        - T: I noticed that you showed the nucleotide change in the DNA—a mutation—that results in mosquitos that are resistant to insecticide. And then you show here the result in the AChE protein. How can a change of one nucleotide result in a mosquito that is resistant to insecticide? **(Challenge question)**

Implementation	Notes
Refer to “Focus on Student Thinking” in the SE key for possible questions to elicit, probe, and challenge student ideas and for an example of dialogue using STeLLA Strategy 6: Engage students in developing and using content representations and models.	

Sample student illustrations





Implementation	Notes

3. Following your teacher's directions, discuss the feedback your team received:

   a) Which pieces of feedback are most helpful to your group? Why?

   b) Are there pieces of feedback that you do not plan to use as you revise your model? Why will you not use them?

Revise your model using the feedback that your team agrees with.

Focus on Student Thinking

- Use appropriate probe (STeLLA Strategy 2) and challenge (STeLLA Strategy 3) questions to reveal student thinking about the revisions they are making to their diagrams.
  - Following are some question you might ask:
    - Say more about how you are addressing that feedback in your illustration. **(Probe)**
    - Tell me your reasoning for ignoring this feedback. **(Probe)**
    - Why do you think you consistently got this feedback? **(Challenge)**
    - How do you show the connection between the mutation and the trait in the organism? **(Challenge)**

Implementation	Notes

Activity Follow-up: Inheritance of Traits
• **STEP 3:** After there are multiple sticky notes with feedback on each chart, have teams take the charts back to their tables and review the feedback they received.
  ○ Encourage teams to group their sticky notes into categories to see patterns and trends in the feedback.
  ○ After sorting their sticky notes, teams should discuss both the patterns and individual feedback to determine how they will use, or not use, the feedback. Teams should record the highlights of their discussion in their workbooks.
• After reviewing the feedback, teams should revise their illustration based on their feedback. As teams work, circulate through the room, using probe and challenge questions to clarify and move student thinking forward about both science ideas and their decisions about the feedback they received.
• Teams should rehang their chart near their table to refer to later in the lesson.
 	
Refer to "Focus on Student Thinking" in the SE key for possible questions to probe and challenge student ideas.	

Lesson 8: Inheritance of Traits

Phase of Lesson: *Synthesize and Summarize*

Main Learning Goal: An individual's traits are determined by the combination of genes they receive from their parents that code for a specific amino acid sequence to make a protein with a specific function.

Focus Question: How can multiple offspring of the same parents have different versions of the same trait?

Unit Overarching Goal:

In plants and animals, similarities and differences among individuals within a species result from proteins coded for by the DNA inherited from their parents. Variations among individuals are the result of mutation, meiosis, and recombination through sexual reproduction.

Notes:

Time: 15 Minutes

STeLLA Strategies

- ❖ Strategy 7: Engage students in constructing explanations and arguments
- ❖ Strategy 9: Engage students in making connections by synthesizing and summarizing key science ideas

Science Ideas

- Individual organisms have characteristics that differ from other individuals of the same species.
- The characteristics (different versions of a trait) of an individual organism are the result of the proteins in that organism.
- There are different explanations, including parents, genes, and mutations, for why these variations occur.
- Evidence helps scientists evaluate the strengths and limitations of explanations.

Common Student Ideas

- Genes are traits.
- Each parent contributes genetic information for certain traits and not others (i.e., he has his mother's eyes and father's nose).
- Different cell types (skin, muscle, bone) found in an individual's body contain different DNA.
- Some characteristics of offspring are determined by the parents' environmentally acquired characteristics.
- DNA is made of proteins and/or amino acids.
- Organisms eat protein; they do not make proteins.

Implementation	Notes
Synthesize and Summarize • **STEP 4:** IN this step, students will work in teams to synthesize and summarize their understanding of science ideas from Lessons 1-8 to develop a scientific explanation that answers the lesson focus question. • Remind students the focus question for the lesson is, “How can multiple offspring of the same parents have different versions of the same trait?” Share that they will now develop a scientific explanation that answers the focus question. • Review the parts of a scientific explanation and the sources of evidence and science concepts from which to develop their explanation. • Students will work in teams to develop their explanation. Encourage students to discuss possible evidence and science concepts and record them in their workbook. When groups are ready, they should write their explanation on chart paper. • As groups work on their explanations, circulate through the room asking probe and challenge questions to reveal student thinking and challenge common student ideas. • If groups finish early or groups are struggling with developing their explanation, invite individuals to “send a spy” to quietly visit the work of other groups and bring ideas back to their group. • Provide instructions for how students will display or submit their explanations.	

Synthesize and Summarize Key Science Ideas

4. The focus question for this lesson was: *How can multiple offspring of the same parents have different versions of the same trait?* With your teammates, develop a scientific explanation for this question. Use the Explanation Tool to think about your claim, evidence, and reasoning. When you are ready, write your explanation on chart paper.

   An example response is shown on page TE L8-26.

Implementation	Notes

Question	
How can multiple offspring of the same parents have different versions of the same trait?	
Evidence from data and observations (e.g. patterns or trends specific to your investigation)	**Reasons your evidence links to your claim. Include science concepts (i.e. patterns or trends that are generalizable across many situations, science vocabulary).**
The DNA sequence is slightly different in different alleles of a gene. A different DNA sequence in the MC1R gene resulted in a protein that was shorter and had a slightly different amino acid sequence and structure. The different structures of MC1R protein determined whether eumelanin or pheomelanin was made in the jaguars. In some cases, two black jaguars had both black and spotted offspring.	The DNA nucleotide sequence in a gene codes for a protein. Proteins determine the traits of an organism. Changing the nucleotide sequence of a gene can result in different proteins. When gametes are made, the pairs of chromosomes separate. If each chromosome has a different allele of a gene, half of the gametes will have one allele and the other half will have the other allele. Individuals inherit one chromosome of each pair (and the alleles on those chromosomes) from each parent, but each sibling could inherit a different chromosome (and alleles) from each parent.
Claim (should answer the question)	
Multiple offspring of the same parents can have different versions of the same trait because they can inherit different combinations of alleles for the gene associated with the trait from their parents.	
Scientific Explanation (Be sure to include the claim, evidence, and reasoning in your explanation. Reasoning includes science concepts and linking words used to connect your ideas in the paragraph.)	
Multiple offspring of the same parents can have different versions of the same trait because they can inherit different combinations of alleles for the gene associated with the trait from their parents. When gametes are made, the pairs of chromosomes separate. If each chromosome has a different allele of a gene, half of the gametes will have one allele and the other half will have the other allele. Offspring inherit one chromosome of each pair (and the alleles on those chromosomes) from each parent. For example, if the father is heterozygous one chromosome in a pair could have the allele A and the other could have the allele a, so half of his gametes will have the A allele and the other half will have the a allele. The same is true for the mother if she is heterozygous. Their offspring could be produced from two gametes that both have the A allele, or two that both have the a allele, or from one that has the A allele and another that has the a allele. That means the same parents could have offspring with the genotypes AA, or aa, or Aa. The two alleles have differences in their DNA sequence, which means they produce proteins with different sequences—and thus, altered structures and functions. Proteins determine the traits, so different proteins result in different traits. In the example above, the A allele could result in a protein that works to make eumelanin, and the a allele could result in a protein that cannot make eumelanin (but only pheomelanin). Then, offspring with the genotype AA and Aa would have black fur and offspring of the same parents with the genotype aa would have spotted fur.	

Lesson 8: Inheritance of Traits

Phase of Lesson: *Summarize and Link*

Main Learning Goal: An individual's traits are determined by the combination of genes they receive from their parents that code for a specific amino acid sequence to make a protein with a specific function.

Focus Question: How can multiple offspring of the same parents have different versions of the same trait?

Unit Overarching Goal:

In plants and animals, similarities and differences among individuals within a species result from proteins coded for by the DNA inherited from their parents. Variations among individuals are the result of mutation, meiosis, and recombination through sexual reproduction.

Notes:

Time: 15 Minutes

STeLLA Strategies

- Strategy 9: Engage students in making connections by synthesizing and summarizing key science ideas

Science Ideas

- Individual organisms have characteristics that differ from other individuals of the same species.
- The characteristics (different versions of a trait) of an individual organism are the result of the proteins in that organism.
- There are different explanations, including parents, genes, and mutations, for why these variations occur.
- Evidence helps scientists evaluate the strengths and limitations of explanations.

Common Student Ideas

- Genes are traits.
- Each parent contributes genetic information for certain traits and not others (i.e., he has his mother's eyes and father's nose).
- Different cell types (skin, muscle, bone) found in an individual's body contain different DNA.
- Some characteristics of offspring are determined by the parents' environmentally acquired characteristics.
- DNA is made of proteins and/or amino acids.
- Organisms eat protein; they do not make proteins.

5. How has your response to the lesson focus question changed over the course of this lesson? In the space below, write a reflection that summarizes the changes in your thinking and what caused your ideas to change. Be prepared to share your reflection with the whole class.

6. During the next class period, we will return to the unit central question, **"What is the best explanation for the similarities and differences we see in individuals within a species—not only for one species, but for every species of plant and animal?"** You will think about this question in the next lesson as you make predictions about the traits of offspring in a family.

   How confident are you that you can answer this unit central question completely?
   Circle a number to show your confidence.

   Not very confident 1 2 3 4 Very confident

Implementation	Notes
Summarize • **STEP 5:** This step provides students with an opportunity to be metacognitive about their learning and consider how their ideas have changed. It also supports students in thinking about how they learn as they consider what caused the change in their ideas. • Ask students to think individually about how their response to the lesson focus question has changed. Have students write a reflection in their workbook that summarizes the changes, including how their ideas changed and what caused their ideas to change. • Ask students to share their ideas with the whole class. Use probe questions to understand and clarify student thinking. *Link to Next Lesson* • Remind students that in this lesson they examined how it is possible for multiple offspring of the same parents to have different versions of the same trait. • Share that, in the next lesson, they will use and apply their understanding to make predictions about the traits of offspring in a family. • **STEP 6:** Ask students to read the prompt and circle the number of the Likert scale that best represents their confidence in their ability to answer the unit central question.	