

Lesson 3: A Closer Look at Proteins

Introduction

You have learned that differences in the types or amounts of a protein may be connected to the differences among individuals of the same species and considered new evidence that supports the three possible explanations for variation. In this lesson, you will look more closely at the structure of proteins and how differences in structure can result in differences in protein function. These differences in protein function can result in two organisms of the same species with different versions of a trait.

Process and Procedure

Lesson Focus Question

1. Write the focus question for this lesson in the box below. After you have written the focus question and your best ideas, turn and talk with your table group about your ideas. As you discuss your ideas, consider which ideas are similar and which are different. Be prepared to share your discussion with the whole class.

A Closer Look at Proteins

2. Proteins are large molecules that are made up of smaller molecules joined together. In this lesson, you will have a chance to learn more about the smaller molecules that make up proteins. To begin thinking about this, imagine the smaller molecules are the same as the pieces in Puzzle Set 1.

With your team, see how many different ways you can put the puzzle pieces together. Record at least 4 different ways you can put them together in the table below.

Order or Sequence of Puzzle Pieces	Shape of Chain When Pieces Are Put Together

3. In Puzzle Set 1, the pieces were all the same shape. You made a prediction about what would happen if the pieces were not all the same shape. Use Puzzle Set 2 to see some of the different combinations you can make when the puzzle pieces are different. Record at least 3 different ways you can put them together in the table below.

Order or Sequence of Puzzle Pieces	Shape of Chain When Pieces Are Put Together

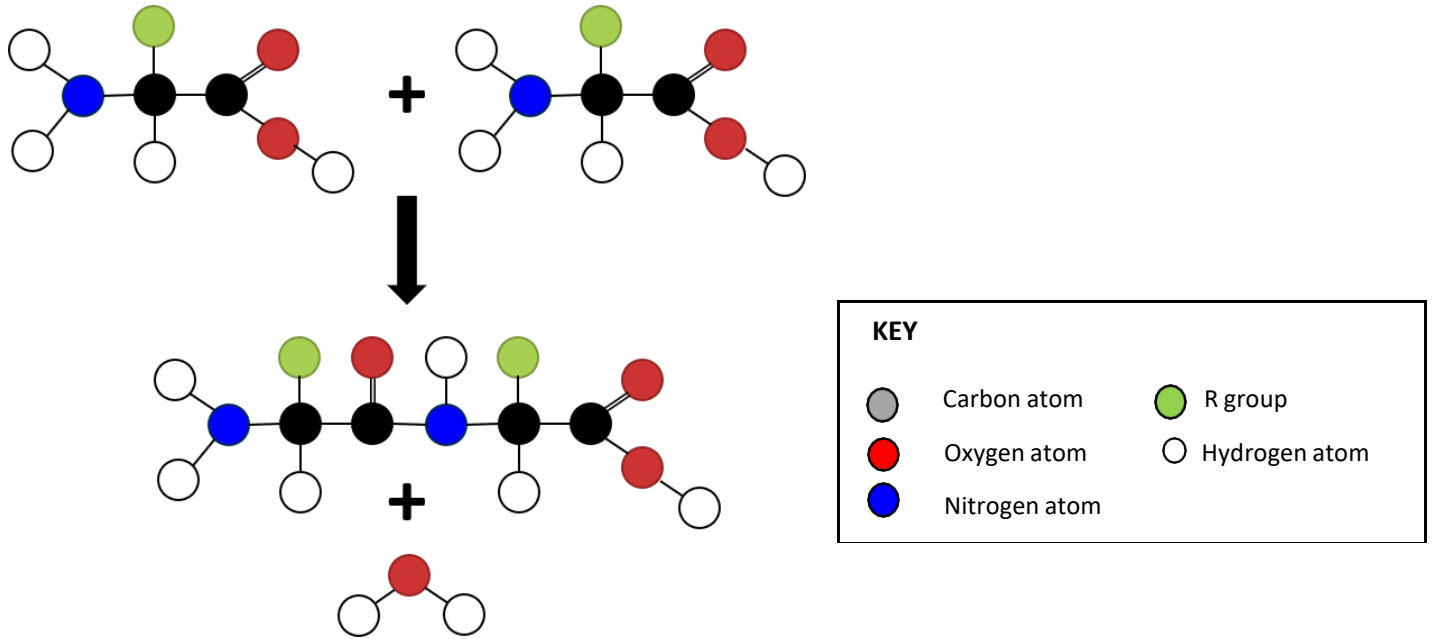
How are the shapes of the chains you made with Puzzle Set 1 similar to or different than the shapes of the chains you made with Puzzle Set 2?

4. When you put a puzzle together, the pieces are the building blocks that form the full puzzle. In the same way, proteins are made of smaller pieces or building blocks. The building blocks of proteins are called amino acids. There are 20 different amino acids found in organisms.

Look at the handout that shows the 20 amino acids. In the table below, list the similarities and differences you see among the amino acids.

Similarities among the 20 amino acids	Differences between the 20 amino acids

5. Like puzzle pieces, amino acids fit together in a specific way in order to bond to one another to make a protein. Look at the example below.



Based on the example, write a rule about how amino acids bond together:

Add any new ideas from the class discussion in a different color.

6. With your team, use the Amino Acid handout to identify the amino acids in your Amino Acid Puzzle Set. Make sure you can identify the following parts of each amino acid:
- Amino group
 - Carboxylic acid group
 - R group

Use the rule you developed to put together the five amino acids in the puzzle set. You can put the amino acids in any order as long as you follow the rule you developed.

7. A short sequence of amino acids bonded together is called a peptide. Visit at least two other teams to compare your peptide to theirs. *Remember that all teams had the same amino acid puzzle pieces as your team did.* Record the differences between the peptides your team observed.

8. Many amino acids are bonded together make a protein. Three facts about proteins that will help you understand them better are:
- Different proteins have different sequences of amino acids.
 - Different sequences of amino acids result in proteins that have different structures.
 - Within a species, a particular protein such as MC1R or hemoglobin will have the same or nearly the same sequence in each individual.

With your team, discuss each statement to make sure you know what they mean. Point to the amino acids and peptides you put together to help you explain your ideas. Use the space below to record your ideas.

9. Study the amino acid sequences for a small portion of the MC1R protein in spotted jaguars and black jaguars. Draw lines between the two sequences to show the similarities between them. The first two are shown for you.

Spotted Jaguar: Val – Leu – Glu – Thr – Ala – Val – Met – Leu – Leu – Leu – Glu – Ala – Gly – Ala – Leu – Ala – Gly

Black Jaguar: Val – Leu – Glu – Thr – Ala – Val – Met – Leu – Leu – Thr – Ala – Gly

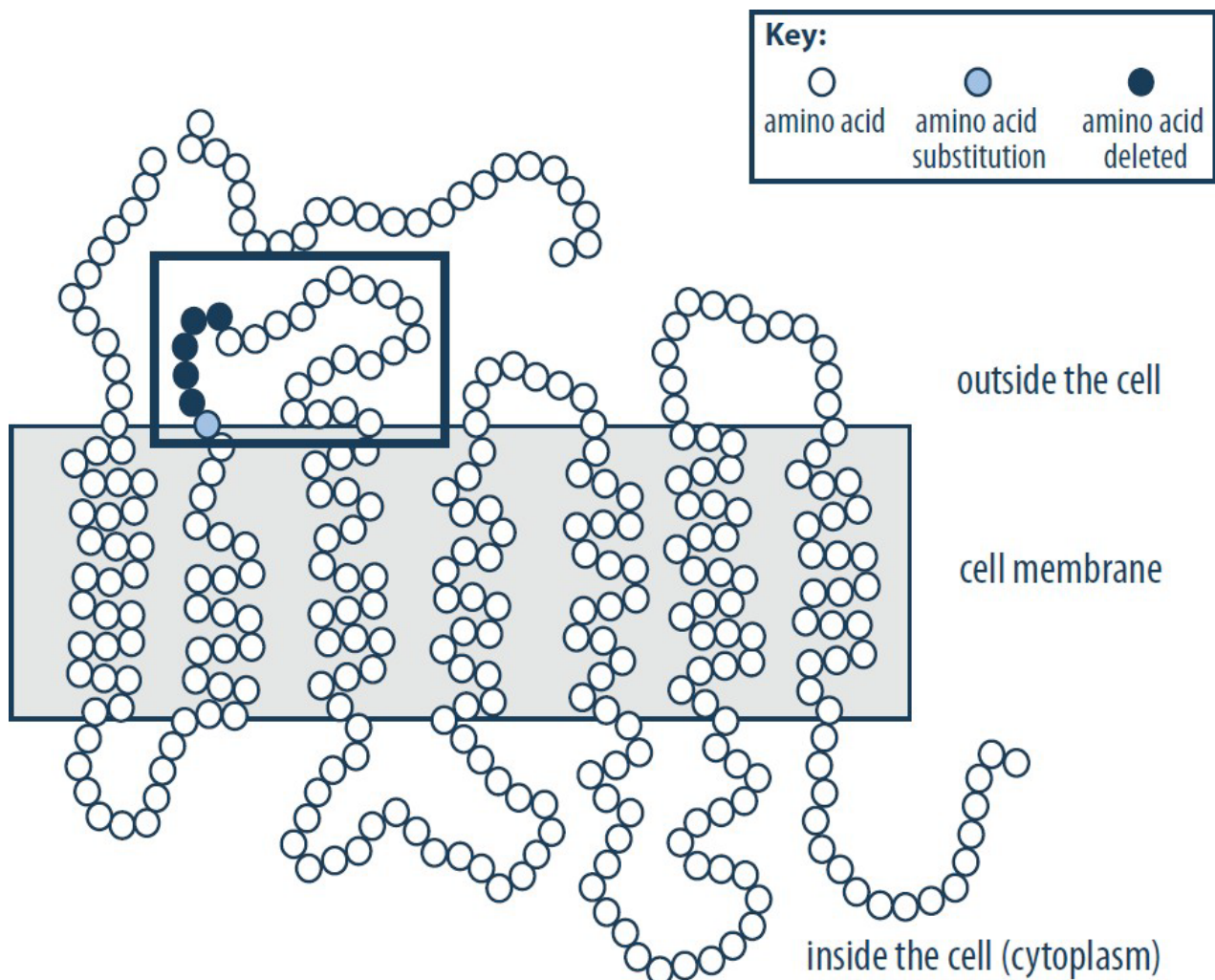
Notice that the places where you did *not* draw lines between the two sequences show the places where they are different.

10. As you read the following information, underline ideas that will help you draw a picture to show the mechanism that causes some jaguars to be black and some to be spotted.

The sequences of amino acids in Step 9 above show a small portion of the MC1R protein. The figure below shows the whole protein. In this figure, the circles represent individual amino acids. All of the circles in the sequence represent the whole MC1R protein. The shaded rectangle represents the cell membrane of a type of cell that produces colored pigment. The portion of the protein above the shaded rectangle is located outside of the cell. The amino acids of the portion of the protein in the shaded rectangle are embedded in the cell membrane. The portion of the protein below the shaded rectangle is located inside the cell in the cytoplasm.

In spotted jaguars, a hormone protein binds to the part of the MC1R protein that has a box drawn around it. This causes the cell to make one kind of melanin, called pheomelanin. Pheomelanin is reddish-orange in color and causes the fur around the spots to be orange.

In black jaguars, the amino acids that are shaded black are deleted. The amino acid shaded blue is the amino acid Thr which was substituted for the Leu amino acid found in spotted jaguars. As a result of these changes, the structure of the protein is different. The hormone protein cannot bind to the MC1R protein because the portion of the protein outside of the cell is smaller. This causes the cell to make a different kind of melanin, called eumelanin. This melanin is dark in color and causes the jaguar's fur to be dark. These black jaguars still have spots, but they are difficult to see because all of the jaguar's fur is dark.



11. Draw a picture to show the mechanism that causes a jaguar to be spotted. Draw a second picture to show the mechanism that causes a jaguar to be black. Label your diagrams so it is clear what each part of your picture represents. In each diagram, show the **hormone protein**, the **MC1R protein**, and the **types of melanin (pheomelanin or eumelanin)**.

Spotted Jaguars

Black Jaguars

Synthesize and Summarize Key Science Ideas

12. In Lesson 2, you learned that there are many different types of proteins that have different functions in a cell. Three types of proteins responsible for differences in jaguar fur color are hormone proteins, regulatory proteins (MC1R), and pigment proteins (pheomelanin and eumelanin).

Look at the characteristics of proteins listed in the left column of the table below. In the right column, write the word “same” or “different” to show if the characteristic would be the same or different between these three types of proteins. Be prepared to share the reasons for your answers.

Characteristic of a Protein	Is the characteristic the same or different between MC1R, hormone, and pigment?
The twenty amino acids that can be used as the building blocks to make a peptide or protein	
The process by which the amino acids bond to each other	
The sequence of amino acids	
The structure of the proteins	

13. The focus question for this lesson was: *How can a protein determine the traits, and versions of a trait, of an individual organism?* Return to your original answer and revise your ideas in a different color. Your goal is to include the most accurate answer that includes all the information you have learned.