5.4: How do Animals Grow? Reading

Purpose for Reading: *As you read this text, work to make sense of how animal body systems build up matter so that animals are able to grow.*

Zooming into Growing

Scientists work to explain things we can observe—like animals growing—by "zooming in" to the smaller systems that animals are made of—cells—as well as the molecules that make up cells. Let's zoom into an animal to figure out how it grows.

Macroscopic scale: We observe animals eating and growing at the macroscopic scale. A calf eats grass and drinks milk from its mother. It grows a little bigger every day until it reaches its adult size. What is happening inside the body at the microscopic and atomic-molecular scales to allow the calf to grow?

Cellular scale: Every cell in a cow's body needs food. During digestion, large molecules are broken into smaller molecules that can be absorbed by the bloodstream. These small organic molecules are then able to move across the lining of the intestines and are transported in the blood to all of the cow's cells. Some of the small organic molecules are combined into large organic molecules (biosynthesis) in the cow's cells. After cells grow larger they can divide. Cells connect to build tissue, organs, and body systems. Cells connect to build tissue, tissues make up organs, and organs comprise the body's systems. How do cells produce the matter—mostly large organic molecules—that they are made of?

This is a puzzling question since only small organic molecules can get out of the blood and through the cell membrane.

Atomic-molecular scale: Large organic molecules in the calf's food and milk are broken down into smaller nutrient molecules during digestion so that they can be absorbed into the blood. These small organic molecules are carried to cells all over the cow's body by the blood stream. Small organic molecules enter cells all over the calf's body and rearrange into large molecules specific to the calf's needs. This building of large organic molecules in all kinds of cells is how the calf grows.

Using Four Steps to Explain Biosynthesis

We can explain biosynthesis—the building up of materials in a living organism—by answering the four numbered questions on the Three Questions handout:

1. How do molecules move to the location of the chemical change?

Small organic molecules In: Small organic molecules (including amino acids, glucose, fatty acids, and glycerol) move out of the blood and into cells all over the animal's body.

2. How are atoms in molecules being rearranged into different molecules?

Small organic molecules are combined to make large organic molecules such as fats and proteins. The chemical change also produces water molecules.

3. What is happening to energy?

The chemical energy stored in the high energy bonds (C-C and C-H) in the small organic molecules remains in the bonds when they are combined into large organic molecules since the bonds are not changed.

4. How do molecules move away from the location of the chemical change?

Cells Grow and Water Out: Cells grow bigger and may eventually divide as more large organic molecules are made. Water leaves the cells.

Athletes & Complete vs. Incomplete Proteins

If you enjoy sports, you might have heard about the importance of diet for athletic performance. Sometimes a sports broadcaster might mention the extreme volume of food that a college or professional athlete must consume to sustain their performance. A common theme is that athletes must consume large amounts of protein in order to enable the muscular development necessary for their athleticism.

Athletes must pay careful attention not only to the *amount* of protein that they consume, but also the *type* of protein in order to allow for adequate muscle growth. Some proteins contain all of the kinds of molecules that a person needs to build their own bodily tissue like muscle. These proteins are called *complete proteins*. If a protein has only a portion of the molecular building blocks needed, these are called *incomplete proteins*.

Animal-based proteins like eggs, meat, or dairy are complete sources protein, providing all of the molecules necessary to build muscle and other tissue. When consumed, the meat or dairy protein is broken down into its basic building blocks, sent to the cells via the blood, and reassembled into human proteins. While a person can get all of the molecular building blocks they need from plant-based protein sources (such as beans, peas, and nuts), these are incomplete sources of protein. As such, a person has to be mindful that they consume a wide variety of plant-based proteins to acquire all of the molecules that they need to make their own proteins.

Multiple Pathways

You have modeled and explained a few examples of biosynthesis in animals. However, there are many other pathways that change small organic molecules into the large organic molecules that animals need to grow, move, and function. Some of these pathways have multiple steps, some can happen in both forward and reverse, some have parts that happen in different cells before the products are combined, and some pathways are cyclical.

Hans Krebs, who you read about at the beginning of the unit, conducted investigations to understand a nine-step cycle. The cycle is known as the Krebs or Citric Acid cycle. This cycle is part of cellular respiration. However, the cycle also results in molecules, such as amino acids, that cells further change to use for growth.

Look at the Metabolic Pathways Poster to see some of the ways in which cells change molecules to be used for growth, movement, or functioning. The solid black arrows show human biosynthesis pathways.

Reading Strategy

Reread this text and complete the appropriate section of your *Matter and Energy in Animals Graphic Organizer*.

Your graphic organizer should now be complete. Review your graphic organizer to see how animals use food in two ways to grow, move, and function.