4.2: How do Animals Get the Energy They Need to Move? Reading

***Purpose for Reading**: As you read this text, work to make sense of how animal body systems move matter and energy into, around, and out of an animal so that animals are able to move and function.*

Zooming into Muscles and Movement

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

Macroscopic scale: We observe animals moving at the macroscopic scale. Different animals can walk, run, swim, jump, or fly. What is happening inside the body at the microscopic and atomic-molecular scales to allow that movement to happen?

Cellular scale: Muscles are made of cells that can contract or relax. Each muscle cell has bundles of fibers; when a muscle contracts, these fibers pull together to overlap. When a muscle relaxes, these fibers overlap less. Animals move when their brains send signals through nerve cells telling the muscle cells to contract. The action of pulling and relaxing of muscles allows animals to move.

Atomic-molecular scale: The brain, nerve cells, and muscle cells all need energy to do their work. All the other living cells in an animal need energy, too. The cells all rely on the same process to get their energy: cellular respiration, a process that releases energy by combining glucose and oxygen.

Using Four Steps to Explain Cellular Respiration

We can explain cellular respiration—and how animals get energy to move—by answering the four numbered questions on the Three Questions handout:

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

Cells need two kinds of molecules—glucose and oxygen—for cellular respiration. Here's how they get each.

Glucose In: All animals need a way to move glucose containing important matter and energy from the digestive system to every cell in the animal's body. As the heart pumps, glucose is carried in the bloodstream to cells all over the animal's body.

Oxygen In: You had another kind of molecule on the reactant side of your chemical change placemat—oxygen. How did those six oxygen molecules get to the cell? The oxygen molecules in your model enter an animal's body through its respiratory system. Many animals including humans, dogs, and birds have lungs for inhaling oxygen from the air. Most animals that live in water have gills that are able to take in oxygen from water. Animals like worms can absorb oxygen from their environment. Insects, like the mealworm, have tiny openings in their exoskeletons that bring oxygen into their bodies.

Remember, all animal cells need oxygen. Oxygen which enters the animal's body through its respiratory system (lungs, gills, skin, or exoskeleton) is carried by its transport system (blood for many animals to every animal cell.

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

Once the glucose and oxygen arrive in the cell they can go through a chemical reaction.

Glucose reacts with oxygen to produce carbon dioxide and water. Here's the chemical equation for this reaction:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6\ CO_2 + 6\ H_2O$$

3. What is happening to energy?

Cells transform the chemical energy in the glucose molecules into energy for cell functions, motion energy, and heat. Because of cellular respiration, muscle cells have access to the energy necessary to contract or relax in response to a signal from the brain sent through nerve cells, so muscles can contract or relax enabling the animal to move. Every cell has a function; cellular respiration makes it possible for each cell to do its specific work.

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

Carbon Dioxide and Water Out: During cellular respiration, energy is released in the cell to enable the work of the cell to occur but what happens to the other products? The atoms found in glucose are rearranged into carbon dioxide and water and are no longer needed by the cell so they are considered waste products. Cells have to get rid of unwanted waste products. Carbon dioxide and water move out of cells and into the blood. The blood carries the carbon dioxide and water to different places in different animals (the lungs, gills, skin, kidneys, or exoskeleton) where they are released into the environment.

Animal movement we observe at the macroscopic scale is possible because cellular respiration is happening at the atomic-molecular scale.

Getting Sore

All living cells constantly undergo cellular respiration, using the energy in the bonds of glucose to produce energy for the cell. But during heavy exercise, some muscle cells cannot get enough oxygen from the blood. Without oxygen, the muscle cells cannot completely break down sugars, but they can get some energy by partially breaking sugar molecules into three-carbon molecules: lactic acid ($C_3H_6O_3$). This buildup of lactic acid can cause the muscles to feel like they are burning and may result in cramping or even muscle failure. When you stop exercising, you keep breathing faster because your muscle cells need additional oxygen to break down the lactic acid. Too much lactic acid can leave your muscles feeling sore.

Reading Strategy

Reread this text using your *Matter & Energy in Animals Graphic Organizer*. You will be able to fill out either the "Materials for growth" or "Energy to move and function" section. Which section should you fill out?