SUCCESS ACADEMY EDUCATION INSTITUTE

Life Science:

Unit 3

Energy and Matter in Organisms: Introduction

Purpose: The Why, What, and How of This Unit

Essential Question: If the average human consumes 2,000 lb of food each year, why don't we weigh 2,000 lb?

Unit Storyline Synopsis: In this unit, scholars build an understanding of what the essential resources for life on Earth are and where they come from. Scholars begin by using yeast and plants as model organisms to discover that glucose and carbon dioxide are essential ingredients for life on Earth. They also consider the interdependence between plants and animals by studying how carbon dioxide and oxygen are exchanged.

Then scholars take a journey through the human body to learn how body systems acquire and cycle energy. They learn that the circulatory and digestive systems transport nutrients around the body, and how the muscular system uses that energy for movement. They see that the systems of the body work together to deliver and use key resources while eliminating their by-products.

Scholars end the unit by studying nutrition and exercise, extending their understanding of how the body regulates energy on a daily basis. Why do people exercise or care about what they eat? Scholars will have a stronger understanding of the choices humans have and will walk away with an understanding of common nutrition and health knowledge that they can apply to their own life.

Why This Unit? What do humans need to survive and, more importantly, *how* do we use those resources to survive? In this unit, scholars will investigate both macro- and microlevel structures and functions to develop an understanding of how energy and matter are captured, transported, transformed, used, and eliminated by the body. Scholars learn about these topics by studying the functioning of their own body systems.

Many scholars understand the necessary resources needed for organismal survival: food, water, and air. They have a strong foundation of cells and molecular components. However, they have yet studied the biological processes that allow for the processing of these resources into usable molecules. Digestion aids in the breakdown of food into a usable reactant, glucose, which is used for cellular respiration to produce energy that allows for basic body functions. Photosynthesis and the human respiratory system work in a complementary nature to provide the gaseous componentsâ€• carbon dioxide and oxygenâ€• that make air a necessary resource for both plants and animals.

What Is the Bottom Line?

Big Idea 1: Photosynthesis and cellular respiration are critical life processes that cycle energy through living things.

- Photosynthesis and cellular respiration work together to support organismal survival.
- Photosynthesis is the process by which plants use sunlight absorbed by the chloroplast to create glucose and oxygen using carbon dioxide and water.
    - The chemical equation for photosynthesis is:

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

- Cellular respiration is the process by which organisms use glucose and oxygen in the mitochondria to create energy, releasing carbon dioxide, water, and heat as by-products.
    - The chemical equation for cellular respiration is:

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

- Photosynthesis and cellular respiration are complementary chemical reactions; by-products from one process form the reactants for the other.

Big Idea 2: Energy is transported and used to support essential life functions.

- Energy is transported throughout an organism to support everyday functions like repair, growth, and the maintenance of homeostasis.
- The digestive system breaks down food into glucose that is in turn broken down for energy by cellular respiration.
- The respiratory system delivers oxygen and removes carbon dioxide, maintaining gaseous balance in the body.
- The circulatory system transports oxygen and glucose to cells for cellular respiration while removing carbon dioxide and other waste.
- Foods provide varying levels of energy based on their composition of macronutrients: carbohydrates, protein, and fats.
- Chemical energy in the form of ATP is transformed into different types of energy as the muscular system uses it to support everyday movement and maintenance of system functioning.
- Once an organism uses available energy to support all necessary functions and additional activities, like exercise, the body transforms it into stored energy and to use for future needs.

How do Next Generation Science Standards practices and crosscutting concepts support mastery of the Big Ideas? Science and Engineering Practices highlighted in this unit:

- **Developing and Using Models**
    - Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
- **Constructing Explanations and Design Solutions**
    - Construct an explanation using models or representations.
    - Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Crosscutting Concepts highlighted in this unit:

- **Cause and Effect**
    - Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- **Systems and System Models**
    - Models can be used to represent systems and their interactionsâ€" such as inputs, processes, and outputsâ€" and energy and matter flows within systems.
    - Systems may interact with other systems; they may have subsystems and be part of larger complex systems.

Safety

Plan carefully for safety in all lessons. The top safety risks in this unit include:

- In Lesson 1, scholars will use yeast. When working with yeast, keep in mind that yeast is generally safe to handle but should not be ingested in large quantities. Because you cannot be certain of what is growing in your yeast culture, do not inhale or ingest the culture. Wash your hands thoroughly after handling, and instruct scholars to do the same. Ensure that scholars wear proper personal protective equipment (PPE) during this activity (gloves, goggles, and aprons).
- Lesson 1 uses baking soda. Review all safety information and the Safety Data Sheet for **baking soda** to ensure proper safety precautions are taken before conducting this lesson. Ensure that scholars wear proper personal protective equipment (PPE) during this activity (gloves, goggles, and aprons).
- Lesson 1 uses ammonia. Review all safety information and the Safety Data Sheet for **ammonia** to ensure proper safety precautions are taken before conducting this lesson. Ensure that scholars wear proper personal protective equipment (PPE) during this activity (gloves, goggles, and aprons).

- Lessons 1 and 3 use vinegar. Review all safety information and the Safety Data Sheet for **vinegar** to ensure proper safety precautions are taken before conducting this lesson. Ensure that scholars wear proper personal protective equipment (PPE) during this activity (gloves, goggles, and aprons).
- Lesson 2 uses bromothymol blue, a pH indicator solution. Review all safety information and the Safety Data Sheet for **bromothymol blue** and ensure proper precautions are taken before conducting this lesson. Ensure that scholars wear proper personal protective equipment (PPE) during this activity (gloves, goggles, and aprons).
- Lesson 2 uses ethyl alcohol. Review all safety information and the Safety Data Sheet for**ethyl alcohol** to ensure proper safety precautions are taken before conducting this lesson. Ensure that scholars wear proper personal protective equipment (PPE) during this activity (gloves, goggles, and aprons).
- Lesson 2 uses iodine potassium iodide solution. Review all safety information and the Safety Data Sheet for **iodine potassium iodide solution** to ensure proper safety precautions are taken before conducting this lesson. Ensure that scholars wear proper personal protective equipment (PPE) during this activity (gloves, goggles, and aprons).
- In Lesson 3, scholars use saltine crackers and bananas. Be conscious of the allergies your scholars have whenever using food products in the classroom. If scholars have severe allergies to the saltine crackers or bananas needed for Lesson 3, you will need to find an alternative. Ensure that scholars wear proper personal protective equipment (PPE) during this activity (gloves, goggles, and aprons).

Important Note: These lesson plans highlight some of the safety risks you should be aware of while teaching these lessons. These safety suggestions are not meant to take the place of a formal science safety training. Please be sure to follow all safety rules from your district, as well as all local, state, and federal science safety guidelines.

Unit Storyline

Engage If the average human consumes 2,000 lb of food each year, why don't we weigh 2,000 lb? Scholars learn the essential nutrients in the food we eat, such as glucose. They use prior knowledge of what organisms need to survive to determine how plants play a role in providing these resources.

- **Lesson 1: A Feast for Yeast** Scholars use yeast as a model organism to discover the first essential ingredient for supporting lifeâ€" glucose. Although humans consume a variety of foods, glucose is the main nutrient our bodies use to make energy.
- **Lesson 2: Surviving on Photosynthesis Like a Moss** Scholars unlock the connection between the glucose organisms need to survive and how plants acquire it.

Explore: Scholars explore what happens when the products of photosynthesis enter the human body by studying systems that transport and transform the essential resources needed for survival, which gives them new evidence to answer the Essential Question.

- **Lesson 3: Rumbling Tummies: The Digestive System** Scholars consider how the breaking down and elimination of waste through this system plays a role in our body weight.
- **Lesson 4: Breathing in Biology: The Respiratory System** Students delve into the respiratory system to explain how oxygen is distributed to all the cells of the body. They uncover that the

by-product of the respiratory system, carbon dioxide, complements plant survival by acting as a reactant in photosynthesis.

- **Lesson 5: Blood Basics: The Circulatory System** The circulatory system delivers nutrients and resources while also eliminating waste. Scholars are one step closer to answering the Essential Question by understanding how the circulatory, digestive, and respiratory systems work together to deliver essential resources to the body and remove waste.

Explain: Scholars unveil what happens to glucose and oxygen when it reaches the cellâ€" cellular respiration! Scholars then explain that after food is broken down into glucose, it undergoes a chemical reaction with oxygen in the mitochondria to produce energy (ATP) and how ATP is used to support almost all body functions.

- **Lesson 6: The Mighty Mitochondria** Scholars use their prior knowledge of chemical reactions to explain that the combination of glucose and oxygen produces ATP, a molecule that acts as the major energy source in the body.
- **Lesson 7: The Energy Engine: How Molecules Move Muscle** Students elaborate on their understanding of cellular respiration by learning about how cells use energy to support muscular movement. This allows them to understand how important ATP is in powering the systems in the body.

Elaborate: Scholars apply their understanding of cellular respiration to the study of exercise and diet. Scholars examine the amount of energy available in different macronutrients, adding more details to their answer to the Essential Question.

- **Lesson 8: Why Do We Exercise?** Scholars apply the concept of basal metabolic rate in different scenarios to develop an understanding of how our bodies gain or lose body weight over time.
- **Lesson 9: The Energy Contest** Scholars investigate how the body uses the macronutrients from food. They will uncover that the specific macronutrient composition of foods plays a role in their overall body weight.

Evaluate: Scholars synthesize all of the evidence accumulated throughout the unit to answer the Essential Question by creating both a written and visual representation of what happens when they eat a burger.

- **Lesson 10: My Burger Story** In the final challenge of the unit, scholars synthesize everything they've learned about the biological processes that support life to create a comic strip that follows the path of a burger after being eaten!

Extra Resources

In addition to the resources linked throughout the guide, use the following materials to help you prepare to launch this unit with scholars:

- **Printable Exit Tickets**
- **Printable Lab Notebook**