SUCCESS ACADEMY EDUCATION INSTITUTE

Life Science:

Unit 3

Energy and Matter in Organisms: Lessons

Lesson 1: A Feast for Yeast (Two Days)

Lesson Objective: Scholars understand that glucose is the main nutrient our bodies need to survive and that it is derived from most foods. Materials Needed

- For the teacher: 1 L of solution per class (see directions and ingredients under “Materials Prep”), glucose-containing snack or drink (something that contains corn syrup or fructose), yeast culture plate prepared for each group of scholars, green paper to use as background for spectrophotometry, wire loops for seeding scholar test tubes
- For each group: 1 tube rack, 5 × 13 mL glass test tubes, 6 plastic transfer pipettes, 5 mL graduated cylinder, small beakers to hold media material test solutions, wire loop
- For each scholar: gloves

Prep

- Materials Prep:
    - Day One
        - Yeast cultures are simple to set up. Find instructions **here** for how to safely culture yeast for use in this investigation.
        - Mix 1 L per class each and then sterilize the solutions by microwaving or boiling before setting to cool:
            - 10% vinegar solution (100 mL pure vinegar in 900 mL distilled water)

        - 10% baking soda solution (100 g baking soda in 900 mL distilled water; dissolve baking soda and then add water to 1 L)
        - 10% sugar solution (100 g sugar in 900 mL distilled water; dissolve sugar and then add water to 1 L)
        - 10% ammonia solution (100 mL pure ammonia in 900 mL distilled water)
        - Distilled water
    - Day Two
        - Have a glucose-containing snack or drink on hand in case scholars have difficulty remembering where most of our sugar comes from.
        - Cut a cardboard box to hold test tubes for spectrophotometry as shown in the link above. Alternatively, have cups on hand to pour samples into and cut the box accordingly.
        - Have scholars bring their cell phones to class.

[**Materials Tip:** Meet with your grade team before teaching this lesson to discuss cell phone use during science class. Ensure that all teachers are aligned on when scholars can have their cell phones with them and when they are returned to their homeroom.]

- Intellectual Prep:
    - **Using Yeast in Biology**
    - **The Unexpected Power of Yeast**
    - **Baker's Yeast Under the Microscope**
    - **Simple Spectrophotometer**

What are scholars doing in this lesson?

- Scholars set up an investigation to determine what substances best support life. Scholars practice experimental design by determining controls and variables and writing a hypothesis.

Day One

Do Now

- Follow the **Do Now plan**.

Launch

- Introduce the Essential Question: If the average human consumes 2,000 lb of food each year, why don't we weigh 2,000 lb?
    - Have scholars share their initial ideas in small groups and discuss as a class.
        - Add these ideas and predictions to an anchor chart.

- Explain that to understand what happens to the food we eat, we must understand the essential nutrient humans need to survive! Tell scholars that they are going to use yeast as a model organism. This is possible because yeast and humans share many important traits.
    - Yeast are smaller than you can see with an ordinary microscope but multiply quickly when they have the right nutrients.
        - Optional: Show scholars the **Baker's Yeast Under the Microscope** video (end the video around 2:09).

Experiment Adapted from the Genetics Science Learning Center Mystery Yeast Mutation Teachers Guide © 2002 University of Utah. See activity **here**.

- Scholars plan and carry out a procedure for determining what yeast needs to grow.
- Explain that the liquid mixture scholars will use to grow yeast is called media.
    - Once scholars have an approved procedure, provide groups with yeast to begin.
        - Scholars should use the wire loop to inoculate their test tubes with yeast from the agar plates. Choose to model what this looks like for scholars or leave it unknown to enhance Discourse on proper planning of controls and setup of experiments.
- As scholars are working, circulate and press them to explain how their group will include controls.
    - How will you know whether each ingredient helps yeast grow? Are there other things besides what's in the media that might affect how yeast grows?
    - Procedure:
        - Label five tubes A–E and note in your lab notebook which substance is in each lettered tube (vinegar, baking soda, sugar, ammonia, and water).
        - Add 5 mL of each media ingredient to the corresponding tube.
        - Add yeast to each tube, being careful not to contaminate whatever you transfer the yeast with as you move from tube to tube.
        - Wait 24 hours and then observe how much yeast has grown by looking at how cloudy the media has become (compared to control samples).
- Once scholars have completed their setup, they should construct a hypothesis on which ingredients they think will allow the yeast to grow the most.

Discourse Debrief experiment:

- Ask: What were the variables in your experiment? Why was it important to include controls in your experiment?
- Introduce the concept of scientific error. Ask:
    - What steps have you taken to minimize scientific error in your setup?
    - What steps will you take tomorrow when analyzing your results to minimize scientific error?

Make broader connections:

- Have scholars share their hypotheses. When they are explaining their reasoning, press them to connect the yeast model to what it representsâ€" humans!

Accountability (Lab Notebook)

- Construct a hypothesis to explain which ingredient you think yeast needs most in order to survive.

Scholar responses will vary based on their ideas. Assess scholar effort and general understanding that a hypothesis should have a clear claim that answers the question and an explanation that uses science content to make sense of their ideas.

Possible Exemplars:

The yeast will grow best in the baking soda solution because adding baking soda to many things makes it get larger, so the yeast will grow when it is in it.

The yeast will grow best in the sugar solution because most food has sugar in it, meaning that living things need it to survive.

Scoring Award points as follows:

- Score scholars on a 1–4 scale (below expectations through exceeding expectations) based on classwork. Do not penalize scholars for initial misconceptions about content; rather, rate them on effort and whether they explain their claim.
    - Look for the following when scoring scholar responses:
        - A clear claim that identifies one ingredient they believe is most important for yeast survival
        - An explanation as to why this ingredient is the most important for yeast survival
        - High effort shown in writing, with complete sentences and proper grammar/ punctuation seen throughout the response
        - Note: If scholars answer this in the form of a question, they should not receive credit.

Day Two

Do Now

- Follow the **Do Now plan**.

Launch

- What might your cultures look like today? How will you know whether your cultures grew?

- Today scholars calculate how much the yeast grew by measuring the light that passes through the samples. This technique is called spectrophotometry. They use their experiment results to determine what is essential for yeast to survive.
    - When light passes through the sample, if there aren't many cells (not a lot of growth), light passes through without stopping.
    - When there are lots of yeast cells, the light gets caught by the cells on its way through the sample and less light passes through.
    - Scholars will make a **Simple Spectrophotometer** and measure the growth of their yeast sample.

[**Engagement Tip:** Create a competition to see which group makes the most accurate observations.]

Experiment Adapted from the Genetics Science Learning Center Mystery Yeast Mutation Teachers Guide © 2002 University of Utah. See activity **here**.

- Scholars collect data by measuring and recording the amount of light that passes through their yeast cultures.
    - Clear media will indicate that the yeast did not grow.
    - Cloudy/opaque media will indicate that the yeast grew. The more opaque the media, the more cells have grown.
- Once scholars have completed recording their data, have them revisit their hypotheses from day one.
    - Have scholars construct a conclusion to their experiment by supporting or refuting their hypothesis and then explaining their reasoning using evidence from the experiment.

Discourse Debrief experiment:

- Ask: Which tubes of yeast grew?
- Ask: Why do you think some yeast grew better than other samples?

Make broader connections:

- Ask: Why don't we eat bags of sugar instead of all different types of food?

[**Tip:** Do not confirm what types of food have the most sugar. Scholars will discover the specific types of macronutrients that contribute to various levels of glucose later in the unit.]

- Ask: Does the source of sugar matter?
    - Is a 12 pack of soda going to provide the same amount of nutrients as a bunch of carrots?
    - Explain that humans have diverse nutritional needs but one of the most important is a form of sugar. Define **glucose** as the most common form of sugar that organisms need to survive.

Make connections to the Essential Question:

- Ask: If humans need glucose to survive, does that mean the 2,000 lb of food we eat is actually 2,000 lb of glucose? If so, why do we not weigh 2,000 lb?
    - Use this time for scholars to develop their initial ideas about the Essential Question. Refer back to the anchor chart made from day one and add new evidence or ideas accumulated from this lesson.

Accountability (Lab Notebook)

- Write a conclusion. Use evidence from your experimental results to determine whether your hypothesis was correct.

Scholar responses will vary based on their data. Assess scholar effort and general understanding that a conclusion should have a clear claim that answers the question, strong supportive evidence collected in the experiment, and justification/reasoning that uses science content or ideas to make sense of their evidence.

Scoring Award points as follows:

- Score scholars on a 1–4 scale (below expectations through exceeding expectations) based on classwork. Do not penalize scholars for initial misconceptions about content; rather, rate them on effort and whether they explain their claim.
    - Look for the following when scoring scholar responses:
        - A clear claim that identifies whether their data supports or refutes their hypothesis
        - Specific evidence collected from the experiment that supports their claim
        - Justification/reasoning for why this ingredient is the most important for yeast survival
        - High effort shown in writing, with complete sentences and proper grammar/ punctuation seen throughout the response

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Lesson 2: Surviving on Photosynthesis Like a Moss

Lesson Objective: Scholars understand that plants use photosynthesis to obtain glucose. Photosynthesis requires sunlight, water, and carbon dioxide, and it produces oxygen and glucose. Materials Needed

- For the teacher: hot plate, beaker, test tube, glass rod, ethanol, water, leaves
- For each group: ½ of a large stem of a living aquatic plant (like Chara or Elodea canadensis), 1 beaker, bromothymol blue solution with pipette or dropper, dechlorinated water, plastic wrap, plastic straws, light source, 2 plastic petri dishes, 1 preboiled leaf, 1 fake leaf, 1 piece of white paper, iodine solution with pipette or dropper

Prep

- Materials Prep:
    - Aquatic Plant Photosynthesis Lab:
        - Cut aquatic plants into smaller pieces that can fit ½ of a large stem into a beaker
        - Note: It is crucial that the plant is alive the day of the investigation, because nonliving plants will not produce any bubbles or color change!
    - Testing plant leaves for starch
        - Boil leaves in water for 1 minute, then take them out and put into the bottom of a test tube using a glass rod.
        - Place the test tube in boiling water and add enough ethanol to cover the leaf.
        - Let the test tube sit in boiling water until the green color of the leaf disappears.
        - Remove the leaf from the test tube and run it under cold water.
    - Test out experiments ahead of time to ensure that scholars add the correct amounts of each solution that will result in a color change.
- Intellectual Prep:
    - The lab combines two techniques to show the presence of oxygen (bubbles) and a change in carbon dioxide in the solution.
        - **Using Aquatic Plants to Demonstrate Photosynthesis**
        - **Elodea Photosynthesis Lab** by Education.com (Elodea can be substituted with other aquatic plants like Chara or Elodea canadensis. They are not invasive, and there are very few restrictions on their purchase.)
    - **Testing Leaves with Starch: the Technique**

What are scholars doing in this lesson?

- Scholars complete two experiments to reveal the reactants and products of photosynthesis.

Do Now

- Follow the **Do Now plan**.

Launch

- Review what scholars know about plants. Ask:
    - Why are plants important to us? Scholars should mention that plants release **oxygen**.
    - What are organelles that are special to plants?
        - What do we know happens in the **chloroplast**? Scholars should be able to identify that **photosynthesis** occurs in the chloroplast, but they do not have to know the steps of the process.
- Explain that scholars will set up two activities to explore the reactants and products of photosynthesis.

Experiment

- Activity 1: Aquatic Plant Photosynthesis Lab
    - Explain that the solution scholars will be using changes color when carbon dioxide is present. When the solution has a large amount of carbon dioxide, it appears yellow in color; when the solution loses carbon dioxide, it becomes blue in color.
        - Each group fills a beaker â…” way with water. Scholars place a ½ of a stem into their beaker.
        - Each group adds 10 drops of bromothymol blue solution to the beaker and records the initial color of the solution.
        - Scholars place a straw in the beaker and blow bubbles gently into it until the color changes.
        - Scholars tightly seal the beaker with plastic wrap (if gas can escape, the solution will not change colors correctly).
        - Place the covered beaker under a lamp and observe the plant (color change and formation of bubbles should be visible).

[**Tip:** Create a beaker that stays in a dark area to discuss the role of light in photosynthesis.]

- Activity 2: Testing plant leaves for starch
    - Tell scholars that they will be testing real and fake plant leaves for the presence of starch. Say that starch shows glucose is being made because glucose is stored as starch inside a plant.

[**Tip:** Ask scholars why they are also using a fake leaf in today’s experiment. Have them make connections to the controls from the previous lesson.]

- Explain that the solution being used to test for starch changes color to a dark blue-black if starch is present.
- Scholars use preboiled leaves and place one in a petri dish over a white piece of paper. Scholars place a fake leaf on a separate petri dish over a white piece of paper.
- Scholars use a pipette dropper to cover both of the leaves in iodine solution.

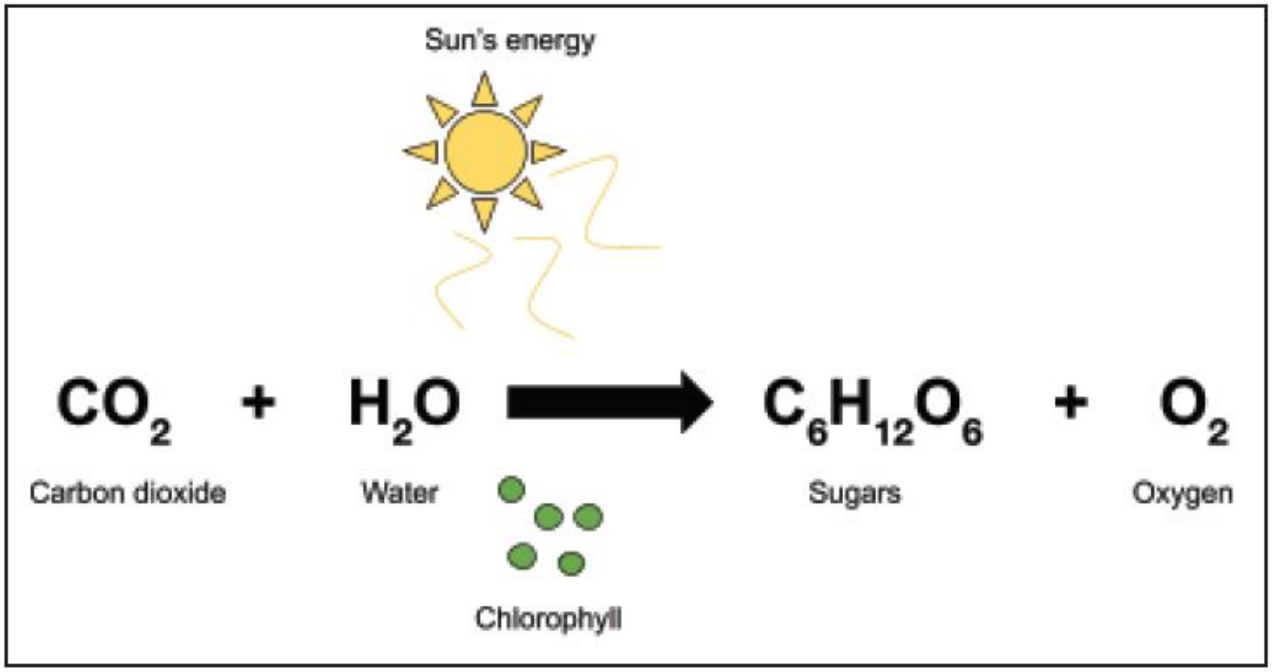
- Scholars observe the color of both of the leaves.
- As scholars are working, circulate and ask:
    - What is the relationship between the color changes, and what is needed for photosynthesis?
    - What is the relationship between the color changes, and what is produced by photosynthesis?
- Scholars analyze the results of each activity to determine what is necessary for photosynthesis to occur and how the process helps a plant survive. Press scholars to make connections between the products of photosynthesis and the resources humans need to survive.

Discourse Debrief experiment:

- Ask: What did you observe happen to the plant stem during Activity 1? What do you think the bubbles were? How do you know?
    - If the color yellow represents the presence of carbon dioxide, what happened to the Elodea in response to the light source?
        - Explain that during photosynthesis, plants use their chloroplasts to absorb light because they contain **chlorophyll**. We added an ingredient to the water when using the straw to blow bubbles into the solution: **carbon dioxide**. Plants use light energy, carbon dioxide, and water to produce oxygen.
- Ask: Based on your results from Activity 2, do plants have glucose? Where does the glucose come from if plants do not consume food like humans do?
    - Explain that during photosynthesis, plants produce glucose by using light energy, carbon dioxide, and water.

Make broader connections:

- Show scholars the **chemical equation** for photosynthesis. Explain that the left side of the equation shows the reactants of the chemical reaction and the right side shows the **products**.



- Ask: How is energy transformed during photosynthesis?
    - Scholars should understand that light energy is transformed from sunlight into chemical energy in the form of glucose.
- Explain that oxygen is characterized as a **by-product** in photosynthesis because it is created in addition to the primary product (glucose).
    - What is the primary product of photosynthesis? Why is this product more useful to plants than oxygen?
    - What happens to the oxygen released by plants?
    - How do plants help humans survive?

Accountability (Exit Ticket) Four scuba divers were talking about the aquatic plants they explored during their last trip to the ocean.

Malik: "Seaweed uses sunlight as its food even though it lives in the water."

Ayesha: "Seaweed does not use food, it only makes food for other organisms in the ocean."

Jeremyah: "Seaweed uses water as food; it lives in the water."

Michele: "Seaweed uses sugar as its food."

1. Which scuba diver do you agree with the most? Explain why you agree, using your knowledge of science to support your answer. [3]

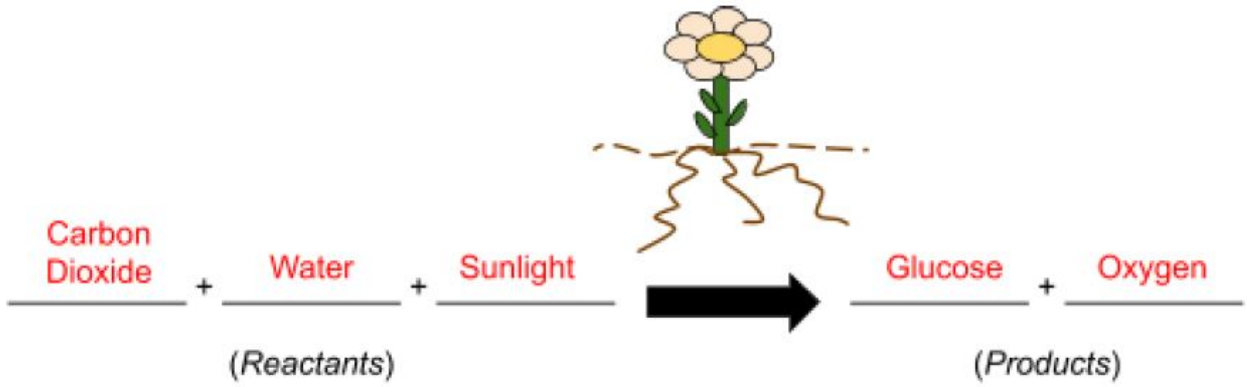
Possible Exemplars:

I agree with Malik, because plants take in sunlight and use it for photosynthesis when they transform it into glucose. Plants use glucose as food to survive, like humans.

I agree with Michele, because plants use sugar as their food from photosynthesis. Plants use sunlight, water, and carbon dioxide in photosynthesis to make sugar to eat.

2. Use the following word bank to fill in the chemical equation for photosynthesis. [4]

Oxygen Carbon Dioxide Sunlight Glucose (Sugar) Water



Scoring

Award points as follows:

1. Award one point for each of the following:
    - A claim indicating agreement with Malik or Michele
    - A clear scientific reason for why they agree with that specific scuba diver that connects to their knowledge of photosynthesis
    - Further supporting information for why their scuba diver's statement is correct based on scientific information learned in class
2. Award two points each for correctly completing the reactant and product sides. The order of reactants and products do not matter.
    - Award partial credit of one point for one or two errors, per side
    - Award zero credit for more than two errors, per side

Lesson 3: Rumbling Tummies: The Digestive System

Lesson Objective: Scholars understand that the organs of the digestive system break down the food we eat to make glucose. The glucose is absorbed into the bloodstream and made available for biological processes at the cellular level. Materials Needed

- For the teacher: 1 set of group materials for demonstration

- For each group: 10 saltine crackers, 1 banana, 1 cup of vinegar, 1 cup of water, 4 plastic cups, 1 pair of panty hose (can also be a section with one end tied off), 1 gallon plastic freezer bag, 1 large bowl for mixing, 1Êº × 6Êº plastic pipe, funnel, scissors

Prep

- Materials Prep:
    - Have a large copy of the map of the digestive system from the scholars' Lab Notebook somewhere that scholars will be able to see it throughout the lesson (on a viewable screen or an enlarged paper copy).
- Intellectual Prep:
    - **The Digestive System**
    - **Digestive System Demo**

What are scholars doing in this lesson?

- Scholars use a model to explore the digestive system to understand what happens to all of the food that we eat each day. Scholars should frequently compare their model to the organs and processes of the digestive system.

Do Now

- Follow the **Do Now plan**.

Launch

- Ask scholars to each take one saltine and begin to chew it in their mouths, but tell them to wait to swallow the cracker. Ask:
    - What is the first step to eating food?
        - Define **mechanical breakdown** as the physical breakdown of food into smaller pieces.
    - As scholars chew the saltine, does the taste change at all?
        - Scholars should notice that the cracker begins to taste sweet. Explain to scholars that the taste changes because the molecules that make up the saltine have been chemically broken down in the mouth.
        - Define **chemical breakdown** as the breaking down of food into nutrients and chemicals.
- How might learning about the digestive system help us understand why we don't weigh 2,000 lb?
    - Once scholars mention the possible idea that the digestive system helps us break down food so that it can be used by the body, define the **digestive system**.

Activity Adapted from **Lesson Idea: Digestive System Experiment | Reach Out CPD** by Twig Education, YouTube, Dec. 18, 2014

- Instruct scholars to follow steps 1–2 in their Lab Notebooks. They will model the beginning of the digestive system processes.
    - Scholars use gloves or a cup to mash the banana and saltines in the bowl and then add water and try to move the mashed-up food through the plastic pipe and into the bowl.

[**Materials Management Tip:** Tell scholars to place their plastic bag directly beneath the pipe as they attempt to fill the pipe with mashed-up food. Have paper towels on hand.]

[**Tip:** During a flex lesson, consider diving into this part of the model. Scholars should mention that there was no way to push the food through the pipe. Use the time to discuss how the body has muscles throughout the digestive system that move food by coordinated muscle contraction. Show the following **video** of food moving down the esophagus.]

- Scholars complete the second half of the experiment by following the steps 3–6 to finish modeling the digestive system.
    - Scholars represent the breakdown of foods with stomach acids and mechanical breakdown through the stomach and intestines.

[**Materials Management Tip:** This could be very messy. Model step 5 before scholars complete it on their own. This will reduce the amount of mess, as scholars will only have a small opening from the bag to pour into the stocking.]

- Scholars throw the remaining food in the stocking in the garbage to finish modeling the excretion of waste through the large intestine.
- Scholars discuss questions in the Lab Notebook. They will use the diagram of the digestive system in their Lab Notebooks to match each step of the procedure to each part of the digestive system.
    - As scholars are working, circulate and press them to connect the model to the real digestive system.

Discourse Debrief activity:

- Walk through the different components of the model used in class and compare them to the parts of the digestive system. Press scholars to make connections between what they were doing to the materials and the function and processes of each organ in the digestive system.
    - Mashing the bananas and crackers alone and then with water
        - Scholars should make connections in the Launch when the saltines were broken down by chewing through mechanical breakdown and further broken down by enzymes in saliva through chemical breakdown.

- Passing the mashed food through a pipe to another bag
    - Scholars should be able to connect the appearance of the pipe to the esophagus in the diagram of the digestive system. Use the diagram to guide scholars in understanding that the bag represents the stomach because it is directly connected to the esophagus.
- Adding the vinegar mixture to the mashed food
    - Ask: Why might we want something acidic in our stomachs?
    - Ask: Would this cause mechanical or chemical breakdown?
        - Explain that the stomach produces acids to further break down food.
- Passing the vinegar and food mixture through the stocking
    - Ask: What does the liquid escaping the stocking represent?
        - Explain that the liquid that leaves the stocking represents the parts of the food that gets absorbed by the body. Show a **diagram** of the lining of the small intestine where villi and microvilli absorb these parts of food. Have scholars make connections between the smallness and number of holes in the stocking to these structures.
- Throwing the leftover food into the garbage
    - Ask: What does the food remaining in the stocking represent?
        - Explain that the large intestine is responsible for absorbing water and eliminating waste out of the body through the colon and rectum.

Make connections to the Essential Question:

- Ask: What parts of the digestive system might help us to answer the Essential Question?

Accountability (Lab Notebook)

- Assess scholar completion of the analysis question in their Lab Notebook after Discourse: “Choose an organ from the digestive system. Explain how its function helps us get glucose from food. Use evidence from the experiment and your knowledge of science to support and justify your response. [3]”

Possible Exemplars:

The mouth helps break down food into glucose through chemical breakdown. During chemical breakdown, acid and enzymes combine with food to break it down into smaller pieces like the banana and crackers being broken down by the water. When food is broken down into smaller pieces, it is easier for humans to absorb glucose later in the digestive system.

The large intestine helps to get rid of parts of food that humans do not use by eliminating waste. This helps us obtain the glucose by separating out and eliminating what we do not need. For example, when the banana was broken down through digestion, parts of the banana were left over in the stocking and thrown away as waste.

Scoring Award points as follows:

- Award one point for each of the following:
    - An accurate organ of the digestive system identified in the scholar's claim
    - Specific evidence from the experiment that explains how the function of the organ identified helps humans obtain glucose
    - Justification/reasoning that further explains how this digestive process will aid in the isolation of glucose for survival

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Lesson 4: Breathing in Biology: The Respiratory System

Lesson Objective: By the end of the lesson, scholars understand that photosynthesis and the respiratory system complement each other: Carbon dioxide, a by-product of human respiration, is used in photosynthesis, and oxygen, which is a by-product of photosynthesis, is used by humans. Materials Needed

- For the teacher: 1 set of student materials, assembled (see Materials Prep for details), nail to make a hole in the soda bottle
- For each group: 20-oz soda bottle (bottom cut off; hole drilled in the cap that's large enough to fit a plastic straw) or a plastic cup (with a hole poked in the bottom), 5–10 plastic straws, 2 small balloons, 1 big balloon, scissors, tape, 5–10 rubber bands, plastic wrap

Prep

- Materials Prep:
    - Empty and clean the soda bottles and cut them in half.
    - Make a hole in the top of each cap large enough for the straw to fit through. Push a nail through the top of the soda bottle. If it will not push through, carefully use a hammer or heavy textbook to push it through.
    - Assemble the working "lungs," but keep them out of sight until scholars finish their own models. Use these lungs as an example during the Discourse if students struggle with the activity.
        - Determine how you will share the videos below with scholars to use during the activity.
            - **Video 1 â€" How to Make Lungs with Balloons**
            - **Video 2 â€" Build a Working Model of Lungs**

- Intellectual Prep:
    - **Science â€” the Respiratory System**
    - **Respiratory System Organs**
    - **Your Lungs and Respiratory System**

What are scholars doing in this lesson?

- Scholars create a model of the respiratory system to learn how it enables our survival by exchanging oxygen and carbon dioxide.

Do Now

- Follow the **Do Now plan**.

Launch

- Besides food, what else do humans need to survive?
    - What do our bodies do with air that helps us survive?
        - Explain that the **respiratory system** is responsible for the intake and transportation of air throughout the body.
- Explain to scholars that today they will build a model of lungs to better understand how the respiratory system works.

Activity Adapted from “How to Make Lungs with Balloons: Life Hacks for Kids” by SemiHigh Production, YouTube, Feb. 5, 2017, and “Working Model of Lungs Make at Home and School Project Best for Class 3, 4, 5” by Pak Science Club, YouTube, Jan.19, 2018

- Using videos, scholars build the “lungs” in table groups.
- As they complete their model, scholars record an observational drawing and discuss questions in their Lab Notebooks.
- As scholars are working, circulate and press them to think about what happens at the cellular level when we breathe.

Discourse Debrief activity:

- Why did we need the balloon at the bottom of the soda bottle?
    - Explain that the balloon at the bottom represents a muscle called the diaphragm that contracts to allow room for the lungs to expand when we inhale air.

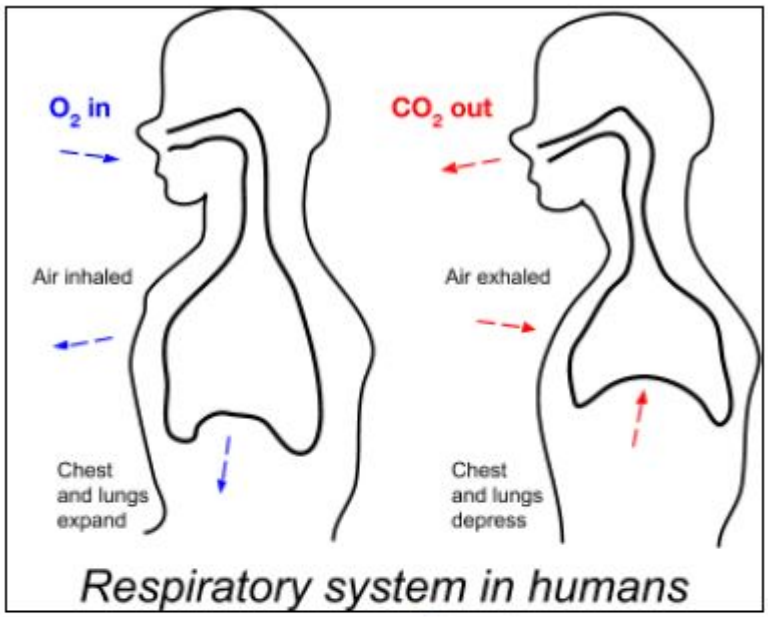
Make connections to the Essential Question:

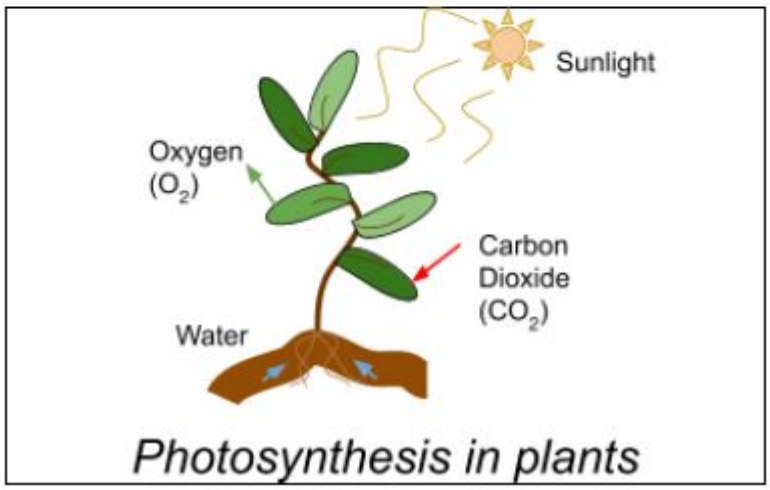
- Which of these gases do we keep when we take in air by the lungs?
    - What happens to the oxygen taken in by the lungs? What do you think it is used for?
        - Scholars may not understand the role of oxygen in the body or will not know it is a reactant for cellular respiration. Use the Essential Question to press scholars to think about how they could be connected so that they can come back to their ideas during the Explain lessons.

Make broader connections:

- What happens to the other gases in the air that we do not need? Why do we need to get rid of them?
    - Have scholars connect back to Lesson 2, where they blew into the bromothymol blue solution and the color turned yellow in response to the presence of carbon dioxide.
- How does the respiratory system compare to the gas exchange we saw in plants?
    - Scholars should be able to make the connection that the gas exchange between plants in photosynthesis contrasts with the gas exchange that occurs in the respiratory system. Press scholars to think about the mutualism that occurs for each organism in the relationship.

Accountability (Exit Ticket) Photosynthesis and the respiratory system benefit each other by giving the other the reactants one organism needs to survive.





1. Based on this information, what do you predict would happen if the number of humans greatly exceeded the number of plants on Earth? Check off all statements that could be true based on your knowledge of science. [2]

The human population would increase because people would have more oxygen for respiration.
The plant population would decrease because plants would have less carbon dioxide for photosynthesis.
The plant population would increase because plants would have more carbon dioxide for photosynthesis.
The human population would decrease because people would have less oxygen for respiration.

2. Circle one statement from question 1 and explain why this could happen. Justify your response with your knowledge of science. [2]

Possible Exemplars:

Statement 3: The plant population could increase because plants need carbon dioxide for photosynthesis, and if there are more humans, they will be breathing out more carbon dioxide during respiration. Photosynthesis creates sugar, which helps plants grow and survive.

Statement 4: The human population could decrease because people need oxygen to breathe, and with fewer plants than humans, there will not be enough oxygen in the air to breath. During photosynthesis, plants make oxygen and release it into the air, which humans use to survive.

Scoring Award points as follows:

1. Award one point for selecting each correct statement.
2. Award one point for each of the following:

    - Supporting evidence that describes the reactants and by-products from each process that complement one another
    - Justification/reasoning that further explains the connection between both organisms and systems

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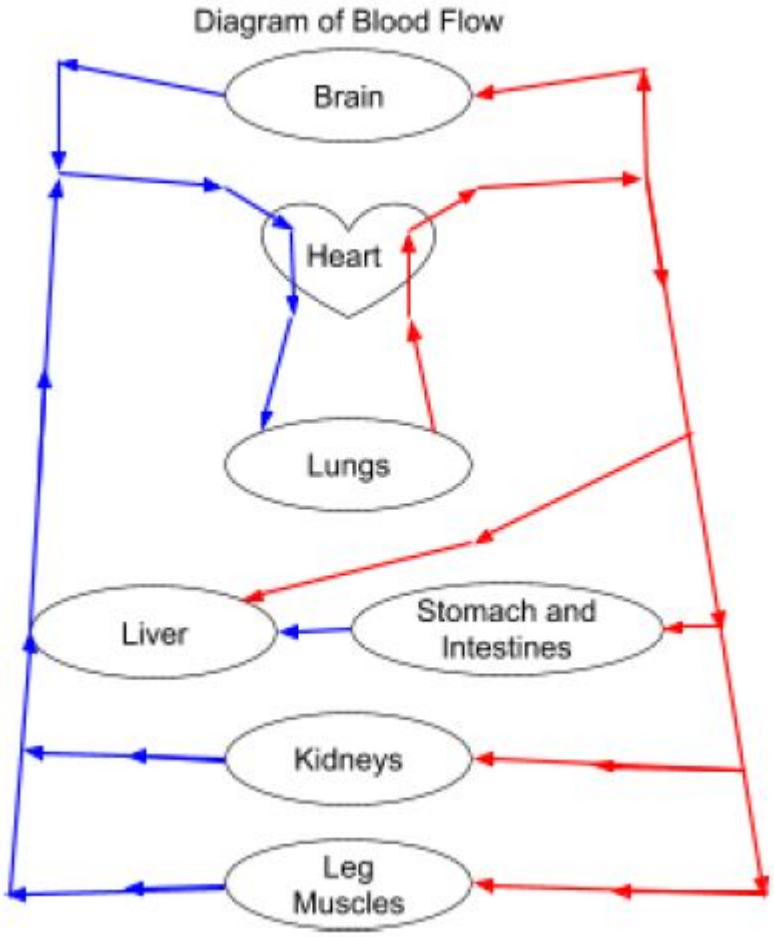
Lesson 5: Blood Basics: The Circulatory System

Lesson Objective: Scholars understand that the circulatory system delivers resources to the organs of the body and connects with both the respiratory and digestive systems. They also learn another important job of the circulatory system: the elimination of waste. Materials Needed

- For the teacher: red and blue masking tape, 40 oxygen cards (white paper), 32 carbon dioxide cards (blue paper), 40 nutrient cards (green paper), 24 waste cards (black paper)
- For each group: a copy of the **Rules** of the “walk-through” model
- For each scholar: 1 **Role Card**; paper clip, string, or transparent tape

Prep

- Materials Prep:
    - Using red and blue tape, create the diagram below on the classroom floor:



- Note that in some cases, masking tape can be difficult to remove. This diagram will be the template on which students will travel, so be sure to make the diagram large enough for students to walk along. Students will also be stationed at each of the organ sites. Provide enough space for at least two students to stand within each organ site as another student walks by. Use red tape to mark the path of oxygenated blood and blue tape to mark the path of deoxygenated blood.
- Cut out **Role Cards**. Mark five nutrient cards with the word “toxin” in large letters. The scholar representing Role Card 8 (liver) will be removing those cards from circulation. Scholars can tape the Role Cards to themselves or use string to wear it around their necks.
- Intellectual Prep:
    - **The Heart and the Circulatory Systemâ€” How They Work**
    - **Your Heart and Circulatory System**

[**Note:** Please note that this activity requires 32 students and should be revised for smaller classrooms and homeschool. If you have fewer than 32 students in a class period, consider combining classes with another teacher. Or you can reduce the number of roles so that an adequate number of students (at least half the class) play the role of blood. You can reduce roles by (1) eliminating roles 13 and 14 (the heart); (2) letting students play more than one role card, with one student performing roles 1 and 2 (the brain); and (3) eliminating Role 8 (one of the liver roles).]

What are scholars doing in this lesson?

- Scholars model blood's rotation through the body in this whole class "walk-through" of the circulatory system.

Do Now Follow the **Do Now plan**.

Launch

- Tell scholars that our bodies are filled with veins, arteries, and capillaries that make up the **circulatory system**. Ask scholars what they think the purpose of these vessels is.
- Explain that the respiratory system takes in oxygen and releases carbon dioxide and uses the circulatory system to help deliver these gases. The digestive system uses these same pathways to deliver nutrients to cells.
- Have scholars look at the "Diagram of Blood Flow" in their Lab Notebooks.
    - Explain that this is a simplified map of how blood travels around your body.
    - Have scholars use their finger to trace one of the possible paths of blood flow. Begin on the left side of the heart (on your right) and stop once you reach the left side of the heart again. Be sure to go in the direction of the arrows.
        - Which organs and structures did you pass through on your path?
    - Repeat steps 1 and 2 by tracing a different path of blood through the human body.
        - Which organs were the same? Which were different?
        - How is this possible?
- Tell scholars that they will do a full "walk-through" of the circulatory system in the classroom.

Activity Adapted from **Blood Circulation Game by the Collaborative Learning Project, which is an adaptation of the Blood Circulation Game** by June Agar. Updated Oct. 7, 2009.

- Give each scholar an individual Role Card and have them read the card to understand their role in the class model and what action they need to perform as their classmates move through the model.
- Have groups review the rules of the model and share the most important aspects of the model as a class before starting.
    - Start slowly and build speed as everyone begins to understand their role.
        - Quiz individual scholars who represent blood on which organ they are passing through. Pause and narrate what is happening at each stage of the process.

[**Engagement Tip:** Challenge a few scholars to a full “walk-through” where they narrate the process and function as they move through the model. They have to start over if they miss a step or provide incorrect information.]

- Change Role Cards so scholars have the opportunity to perform different roles.
- After scholars have an opportunity to change roles, they discuss and answer questions about the circulatory system in their Lab Notebooks.

Discourse Debrief activity:

- Ask: What is the overall function of the circulatory system?
- Ask: Why does blood travel around the body?
    - Ask: In which direction(s) does blood flow? Why?
        - If scholars struggle to recall, have them look back to the “Diagram of Blood Flow” in their Lab Notebooks. Define **unidirectional**.
        - How does the body know how to organize and work this way?
- Ask: Do all parts of the human body use oxygen and nutrients?
    - What do you think happens in our bodies when we run out of oxygen? Nutrients?
        - Scholars should focus on the fact that the circulatory system functions to deliver these essential resources throughout the entire body in an efficient way, allowing all organs to receive and use. They should recognize that because these resources are essential to survival, organs may not function properly if they did not receive them through the circulatory system.

Make connections to the Essential Question:

- Ask: What parts of the circulatory system help us to answer the Essential Question?
    - Scholars should be able to make connections from the model used in class to discern that essential resources are used by different organs and their waste is eliminated through release back into the circulatory system. They should be able to connect the elimination of waste to the idea that we do not weigh as much as we eat. Use the anchor chart created in the beginning of the unit to add and revise initial ideas.

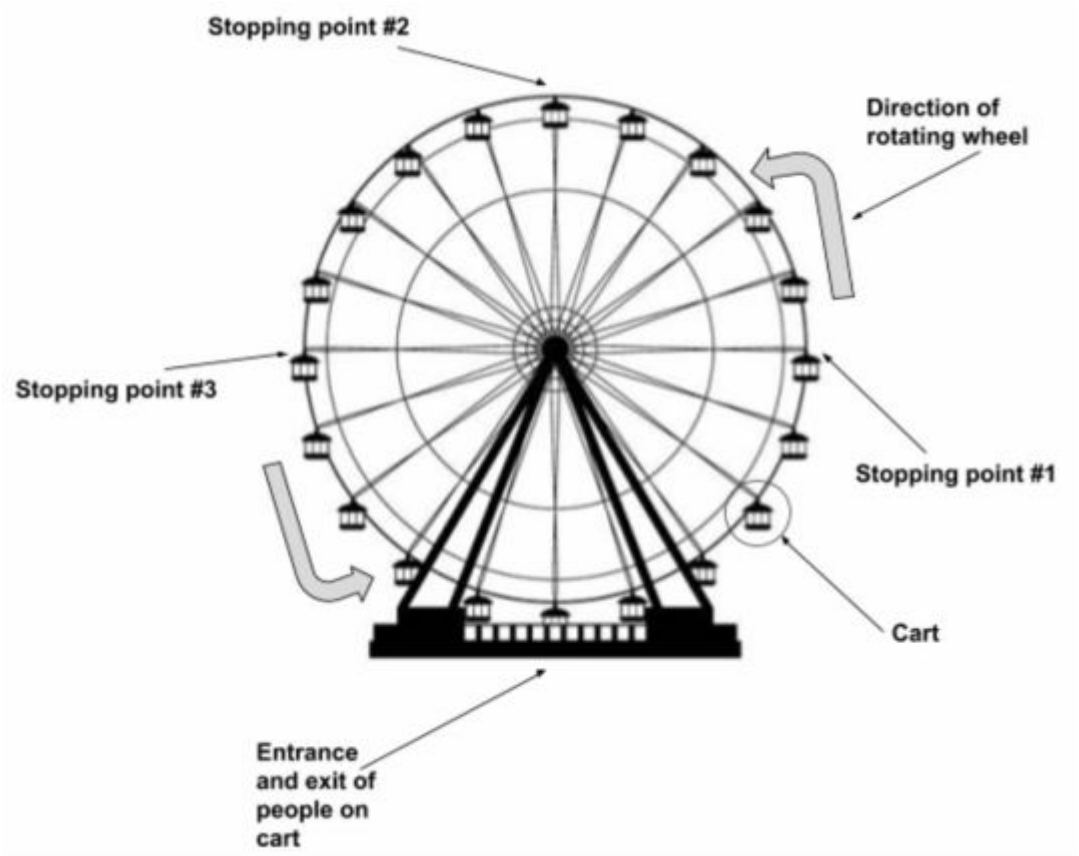
Make broader connections:

- Ask: How do all three systems (digestive, respiratory, and circulatory) work together to help humans survive? (Show a diagram of each system next to the others.)
    - Press scholars to create conjectures that tie all three systems together. Use these conjectures to create an anchor chart for scholars to revisit throughout the unit.

Extend

- Have two student volunteers keep track of how many breaths one student takes in one minute. Track the student's pulse as well (and, if necessary, explain that pulse measures heart rate).
- After taking a baseline measurement of pulse rate and breaths per minute, ask the student to do 20 jumping jacks then take another reading of breath and pulse rate.
- When breathing rate increased, what happened to heart rate?
    - Why might the number of breaths a person takes and their heart rate be connected?
    - Why do you think we breathe faster during exercise?

Accountability (Exit Ticket) The most popular ride at the Humboldt County Fair is the Ferris wheel. People enter and exit carts at the bottom of the Ferris wheel, and each cart has seats for four people. A Ferris wheel rotates the carts of people around the entire circle, stopping at different points. Below is a picture of the Ferris wheel with its different parts labeled.



1. The parts of the Ferris wheel can be compared to the parts of the human circulatory system. Complete the sentence to accurately compare the Ferris wheel and the circulatory system. [4]

The heart is like the Ferris wheel motor, because the heart beats constantly to push blood around the body just like the motor pushes the Ferris wheel.

The organs in the body are like the stopping points, because blood stops at different organs of the body just like the Ferris wheel stops at different points during its rotation.

Scoring Award points as follows:

1. Award one point for each of the following:

    - Explaining why the heart is like the Ferris wheel motor (up to two points)
    - Explaining why the organs are like the stopping points (up to two points)

Lesson 6: The Mighty Mitochondria

Lesson Objective: Scholars understand that cells carry out cellular respiration in the mitochondria using glucose and oxygen. This chemical reaction produces ATP, a substance that provides the energy needed for basic body functions. They also learn that carbon dioxide and water act as by-products of cellular respiration. Materials Needed

- For each scholar: the **Dragon Dilemma** computer game, red and blue colored pencils or markers for the Exit Ticket

Prep

- Materials Prep:
    - Sign up for “Legends of Learning” and find the Dragon Dilemma game:
        - Go to **Legends of Learning** and fill in your information to register
            - Select “1 Play a Game.”
            - Select “Middle School” and “Physical Science.”
            - Slect “PSD.3-2 Chemical Reactions in Cellular Respiration.”
        - Invite your scholars to play the Dragon Dilemma game:
            - Invite your scholars to play the game by sending them a link from your account.
            - Give scholars your unique teacher code so they can launch the game.
    - Go through the simulation to determine what scholars should walk away understanding from each part of the game.
- Intellectual Prep:
    - **Steps of Cellular Respiration** from Khan Academy
    - **Mitochondria: Power Producers**
    - **ATP & Respiration**

What are scholars doing in this lesson?

- Scholars use a computer model to bring the function of the mitochondria to life. They use their prior knowledge of chemical reactions to explain that the combination of glucose and oxygen produces a new substance, ATP.

Do Now

- Follow the **Do Now plan**.

Launch

- Ask scholars what they already know about the **mitochondria**.
    - Why do you think people refer to mitochondria as the “powerhouse” of the cell? Show scholars a **diagram** of the mitochondria.
        - Explain that when glucose and oxygen reach the cell, they enter the mitochondria, where they undergo **cellular respiration** in the inner membrane to produce energy, in the form of **ATP**, for the cell.
            - What do you notice about the structures within the mitochondria?
            - How could having lots of space in the inner membrane be helpful?
                - Help scholars notice that there is a lot of space within the mitochondria because of the inner folds. Press scholars to make connections between the available space for energy creation and how much energy can be created at the same time.
- Today scholars play a computer game that ties in their knowledge of the digestive, respiratory, and circulatory systems to simulate cellular respiration throughout the day.

Activity

- Scholars complete the Dragon Dilemma game independently.
    - As scholars complete the game, press them to connect what the dragon needs to do to stay energized to systems they have learned about during the Explore lessons.

[**Tip:** Return to this idea during the next lesson when scholars make the connection between ATP and muscular function. Scholars should be able to understand that they need to collect more food to fuel cellular respiration in order to create more ATP for the lungs to contract and expand so they can breathe in more oxygen.]

- After completing the game, scholars discuss what they experienced and answer questions about cellular respiration in their Lab Notebooks.

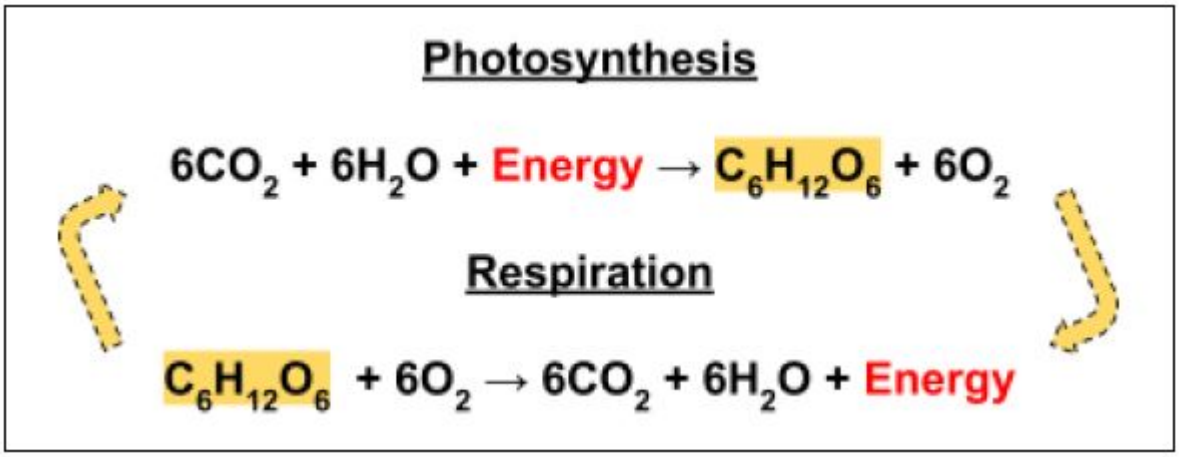
Discourse Debrief activity:

- Ask: What did your character in the game need to do in order to carry out cellular respiration?
    - What was challenging about the game? What does that make you think about the natural world?
        - Scholars should mention that it was difficult to catch oxygen from the air due to the amount of energy needed and the composition of gases in the air during different environmental conditions. Push scholars to connect this challenge to what they know about climate change in the natural world.
    - What was easy about the game? What does this make you think about the natural world?
        - Scholars will be able to talk about the ease of consuming food due to the amount of time given and the likeliness of finding a pattern. Push scholars to connect this ease to what it is like to find and consume food in the natural world.

Make connections to the Essential Question:

- Show scholars the chemical equation for cellular respiration.

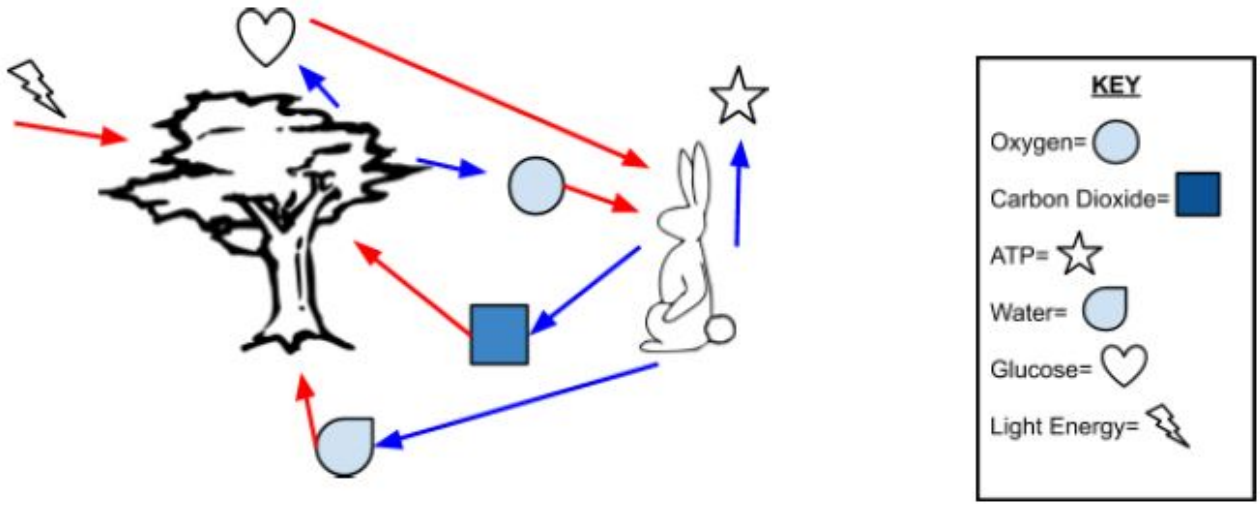
- Ask: What are the reactants of cellular respiration? How do you know? Where do we get these reactants from?
- Ask: What is the product of cellular respiration? How do you know?
- Ask: What happens to the product after cellular respiration is over?
- Scholars will have a vague idea that ATP will be used as energy for different purposes in the body. In the next lesson, they will learn the vast range of purposes that ATP is used for throughout the entire body.
- Ask: What are the by-products of cellular respiration? How do you know?
- Remind scholars what a by-product is by connecting back to how oxygen is released during photosynthesis.
- Ask: How is energy transformed during cellular respiration?
- Scholars should be able to articulate that chemical energy from glucose is transformed into a different type of chemical energy, ATP. This concept may be difficult for scholars to grasp. Explain that for each molecule of glucose consumed, 38 molecules of ATP are produced, to show that chemical energy is being transformed into many molecules.
- Display both chemical equations of cellular respiration and photosynthesis.



- How does the chemical equation for photosynthesis compare to the chemical equation for cellular respiration?

Accountability (Exit Ticket) [**Materials Tip:** Have blue and red colored pencils readily available for scholars during the Exit Ticket.]

1. Use the provided key and any additional symbols needed to draw a model below that shows how a rabbit and a tree cycle matter and energy through the processes of photosynthesis and cellular respiration. In your model, make sure you include all reactants and products of both processes. [2]



In your model above:

1. Use a **red pencil** to draw arrows that represent the direction of the reactants. [1]
2. Use a **blue pencil** to draw arrows that represent the direction of the products. [1]

2. Which organelle should be studied in these organisms to better understand their cellular respiration? Circle the best answer choice below. [1]
    1. Chloroplast
    2. Cell membrane
    3. Nucleus
    4. Mitochondria

Scoring Award points as follows:

1. Award one point for each of the following:
    - Use all symbols in the key
    - A drawn or symbolic representation of both a tree and a rabbit
    - Includes red arrows correctly representing reactants for cellular respiration in the rabbit and photosynthesis in the tree
    - Includes blue arrows correctly representing products for cellular respiration in the rabbit and photosynthesis in the tree
2. Award one point for selecting answer D.

Lesson 7: The Energy Engine: How Molecules Move Muscle

Lesson Objective: Scholars understand that ATP is used as a power source for muscle contraction and can explain ways that muscles play a role in our basic body functions. Materials Needed

- For the teacher: set of student materials for demonstration
- For each group: the **ATP Muscle Kit** from Carolina Biological Supply Company (or a similar kit including striated muscle sample on microscope slide and ATP solution), microscope
- For each scholar: link to article **"Your Muscles"**

Prep

- Materials Prep:
    - Prepare striated muscle samples on slides.
- Intellectual Prep:
    - Review the **Teacher's Manual and Student Guide** for the **ATP Muscle Kit** from Carolina Biological Supply Company (or a similar kit including striated muscle sample on microscope slide and ATP solution).
        - Note: Access to the student procedure requires purchase of the kit through Carolina Biological Supply Company.
    - **Muscle: A Specialized Contractile Machine**
    - **Your Muscles**

What are scholars doing in this lesson?

- Scholars observe muscle cells under the microscope.

Do Now

- Follow the **Do Now plan**.

Launch

- Ask scholars what was necessary for the yeast to grow.
    - What would happen if the cells did not have enough glucose to complete cellular respiration?
        - How do you think ATP is used in the body after it is created?
            - Chart these responses to return to at the end of the lesson when scholars have a more complete understanding of ATP.
- Today scholars use a model to determine how ATP from cellular respiration is used throughout the body and deepen their understanding of the body by reading various scientific texts that describe the muscular system.

Experiment

- Working in groups, scholars observe the muscle tissue before and after adding the ATP mix by following the procedure provided in the **Teacher's Manual and Student Guide** for the **ATP Muscle Kit** by Carolina Biological Supply Company. They diagram their observations in their Lab Notebooks.
    - Scholars should be able to see the muscle contract when the ATP mix is added. Press scholars to think about when they've noticed their own muscles contract to push their thinking that muscle contraction is essential in performing basic body functions.
- Scholars work independently or in pairs to read through the article on the muscular system and take notes in their Lab Notebooks.
    - Scholars choose one muscle they learned about and predict how that muscle would be affected by the slowing of cellular respiration. Scholars share their predictions with their group.
    - Groups should then discuss how the overall body would be affected by the slowing of cellular respiration.
- As scholars are working, circulate and press them to think about how ATP is being used by the body after it is created through cellular respiration.

Discourse Debrief experiment:

- Ask: What happened to the muscle tissue when ATP was added?
    - Have scholars flex their bicep muscles.
        - What is allowing your muscles to do this? Can your muscles stay contracted forever? Why?
            - Scholars should begin to articulate that ATP is needed for muscle contraction and that ATP must be replenished in order to keep contracting the muscles.
        - How is energy being transformed during muscle contraction?

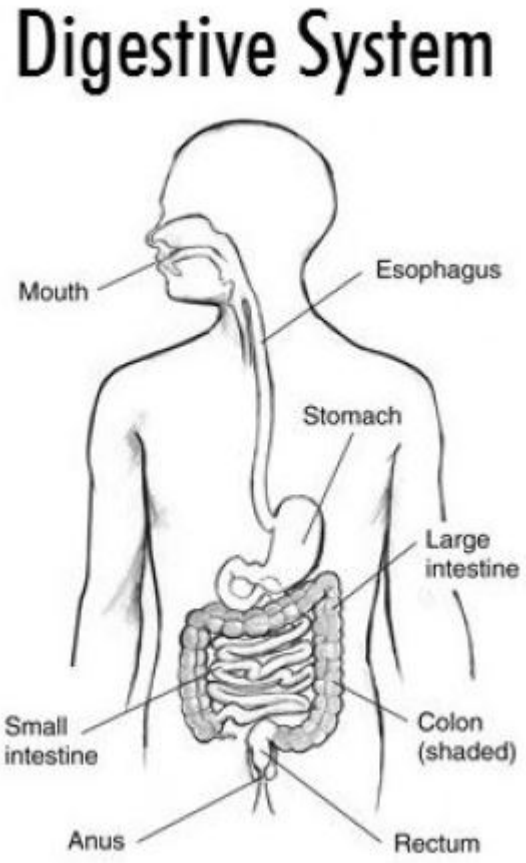
Make connections to the Essential Question:

- Ask: Why is cellular respiration so important for our survival?
- Ask: How does understanding what ATP is used for in the body help us answer the Essential Question?
    - Scholars should be able to articulate that food is broken down into smaller molecules that are transformed into ATP through cellular respiration, which is used for almost all essential body functions. Once it is used and transformed by the body for different uses, it no longer remains a “weight” in our body.

Make broader connections:

- Ask: What do you think might happen if the muscle cells, or any cells, didn’t have enough energy?
    - What specific parts of the body use muscles to function?
        - Define **muscular system**.
    - How would you be affected if these muscles did not have enough ATP? Have scholars share the predictions they created in their Lab Notebooks after reading the different scientific texts.

Accountability (Exit Ticket) The esophagus is a tubular organ in the digestive system (seen in the image below). It helps move food through the digestive system by connecting the mouth to the stomach. After food is mechanically and partly chemically digested in the mouth, the esophagus works as a muscle to push food downwards toward the stomach. This movement is called peristalsis. When the muscle contracts, the top and bottom of the esophagus prevent food from moving freely from the mouth into the esophagus or food from moving into the stomach. When the muscle relaxes, like when someone swallows, the food can pass into the stomach.



1. What might happen to a human's esophagus if they were not getting enough ATP from cellular respiration? Explain your response using evidence from the excerpt above. Justify your response using your knowledge of science from the unit. [3]

If a human was not getting enough ATP from cellular respiration, he or she might struggle to get essential nutrients from food. According to the text, the esophagus is a muscle, and when it uses ATP to contract, it helps move food down to the stomach to continue the digestive process. If food cannot travel through the digestive system, the body will not have nutrients like glucose for cellular respiration and will therefore have less energy.

Scoring Award points as follows:

1. Award one point for each of the following:

    - An accurate claim identifying how humans would be affected by the esophagus not contracting
    - Supporting evidence from the text that explains how the esophagus functions as a muscle in the digestive system
    - Justification/reasoning that demonstrates a clear understanding of how low amounts of ATP affect muscular movement and overall body function

Lesson 8: Why Do We Exercise?

Lesson Objective: Scholars understand how activity levels and diet impact the human body's demand for glucose. Materials Needed

- For the teacher: various packaged foods (to show scholars where nutritional label appears)
- For each group: a copy of the **BMR Calculator**, a copy of the **Character Profile Reference Sheet**
- For each scholar: calculator

Prep

- Materials Prep:
    - Print or send out reference sheets for each group.
    - Bring in various packaged foods to show scholars where nutritional labels are found.
- Intellectual Prep:
    - **How Many Calories Do I Burn in a Day?**
    - **What Is Basal Metabolic Rate?**

What are scholars doing in this lesson?

- Scholars use their mathematical skills to determine how different activity levels and diet lead to the demand for more glucose for cellular respiration or the need to transform it into stored energy for later use.

Do Now

- Follow the **Do Now plan**.

Launch

- Ask scholars for examples of different types of exercise.
    - Why do people exercise?
    - What happens when you exercise too much or not at all?
- Our Essential Question states that the average person consumes 2,000 lb of food per year. Why do people keep track of how much they eat each day, week, or year?
    - Explain that food is primarily tracked through calories. Show scholars where information for calories is usually found on nutrition labels.
- Today scholars investigate exercise by using their mathematical knowledge to determine how activity affects your overall health.

Activity

- Working in groups, scholars use the two exemplar profiles to calculate how many calories the characters use in one day and how many calories they consume based on what they eat during the day.
    - Explain that people calculate their **basal metabolic rate** (BMR) to determine how many calories they should be eating to maintain their overall weight and health.
        - Scholars calculate the BMR of each character by using the information provided in their profile, calculate how many calories each character consumes in one day based on the information provided in their profile, and then subtract the number of calories consumed by the number of calories used for each character.
- Scholars ponder what happens when you eat more calories than you use in one day or what happens when you eat fewer calories than you use in one day and answer questions in their Lab Notebooks.

Discourse Debrief activity:

- Ask: What happened to Character B after one day?
    - What do you think would happen over time to the extra calories in the body?
        - Explain that the body only uses the glucose needed to create enough energy to complete basic body functions. The body transforms extra glucose in the body to **stored energy** in the form of glycogen or fat to use at a later time. Continually eating excess calories causes your body fat stores to expand and your overall body weight to increase.
            - Do not confirm what types of foods create greater amounts of stored energy. Scholars will discover it in the next lesson.
            - When do you think humans rely on the stored energy to perform basic body functions?
- Ask: What happened to Character A after one day?
    - What was different about his or her profile compared to Character B's? How does this compare to the amount of calories in his or her body at the end of the day?
    - What do you think would happen over time if this character consumed fewer calories than his or her BMR?

Make connections to the Essential Question:

- Ask: How might understanding calories and exercise help us answer the Essential Question?
    - Scholars should be able to articulate that calories from the food we eat are used during exercise in addition to aiding in the basic essential body functions learned in the previous lesson.

Make broader connections:

- Ask: Why do people exercise?
    - Scholars should be able to identify that there is benefit in maintaining your overall weight. Push scholars to think about how exercise might create other health benefits, such as the strengthening of muscles, circulation, and respiration.
    - What are other reasons people exercise besides maintaining their overall weight and health?

Extend

- Show scholars a **list** of different types of exercise and the number of calories they use.
    - Why do you think different exercises burn different amounts of calories? If someone runs frequently, what do you think their diet consists of? Why?

Accountability (Exit Ticket) During most parts of the year, brown bears consume 20 lb of food each day. Before the winter season, brown bears consume almost 90 lb of food each day! During the winter season, the brown bear goes into a dormant stage, known as hibernation, because when the temperature becomes colder, food becomes more scarce. Below is a picture of a brown bear once the winter season has passed and they wake up from their deep sleep during hibernation.

Image credit: **Carl Chapman from Phoenix, usa**, **CC BY 2.0**, via Wikimedia Commons

1. How does the brown bear's change in diet help it survive hibernation? Use your knowledge of science to support your response. [2]

If brown bears consume up to 90 lb of food each day before hibernation, they can use that stored energy when food is scarce during winter. If an organism consumes more calories than it uses each day, it is more likely to gain weight, because the food is converted into stored energy, which usually is stored as fat.

2. Why do brown bears stay in a dormant stage during the winter season instead of completing their daily activity? Use your knowledge of science to support your response. [2]

Brown bears stay in a dormant stage during the winter season because it helps to conserve their energy. If the brown bears are active or exercising, they will use their stored energy before the end of winter and will not have enough to survive.

Scoring Award points as follows:

1. Award one point for each of the following:

    - An accurate claim identifying that brown bears can utilize the stored energy when food is scarce

- Scientific reasoning that demonstrates that an increase of calories without change to daily activity or exercise would result in weight gain

2. Award one point for each of the following:

    - An accurate claim identifying that exercise would use the brown bear's stored energy
    - Scientific reasoning that demonstrates that exercise uses calories and that if brown bears do not have enough stored energy throughout the rest of their dormant stage, they will not survive

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Lesson 9: The Energy Contest

Lesson Objective: Scholars discover that foods rich in carbohydrates provide fast usable energy for cellular respiration, whereas foods rich in protein and fats provide different benefits, like aid in muscle repair or stored energy supplies. Materials Needed

- For each scholar: computer/device, copy or link to the **Sports Nutrition** article

Prep

- Materials Prep:
    - Review the **Eating and Exercise PhET Simulation** to show scholars how they can best use the information it provides to support their explanation.
        - Set up on a viewable screen for the class during the investigation.
- Intellectual Prep:
    - **Fuel for Pre and Post Exercise**
    - Review the **Sports Nutrition** article and **Eating and Exercise PhET Simulation** scholars will use in class.

What are scholars doing in this lesson?

- Scholars investigate how the body uses the different macronutrients that make up the food we eat. They will use their research to compare the value of each macronutrient and determine which is most useful for efficient and fast energy creationâ€" carbohydrates. Scholars will discover that the specific macronutrient composition of the foods they consume plays a larger role in their overall body weight.

Do Now

- Follow the **Do Now plan**.

Launch

- Tell scholars to think of the last time they were active. Ask what food they think gives us the most energy.
    - Explain that all food is composed of three main types of macronutrientsâ€" carbohydrates, protein, and fatsâ€" which contribute to the overall calories a food has.
    - Show scholars a **video** of how the three main types of macronutrients found in the foods we consume can be used in the body.
- Today scholars explore the different nutritional value of foods to understand their varying benefits in creating reactants for cellular respiration.
    - Tell scholars that exercise requires fast and readily available energy. Scholars use this information to craft the best meals to eat for exercise.

Activity Adapted from Eating and Exercise by **PhET Interactive Simulations**, University of Colorado Boulder

- Scholars use resources to gather evidence about each type of macronutrient found in food to develop the best meals to eat for exercising.
    - Scholars read the **Sports Nutrition** article to have a deeper background on the three different macronutrients found in foods.
        - Scholars should record initial notes on the type of macronutrients they will want to base their meals on.
    - Teachers guide scholars through the **Eating and Exercise PhET Simulation** to learn what different foods are composed of and how the body reacts to regular exercise and eating those foods.
- Scholars will display these meals by drawing a diagram on a plate and also explain why their meal provides the most energy for exercise.

Discourse Debrief activity:

- Have scholars share their diagrams and explanations of what types of food are best to eat for exercise. Press scholars to describe the connection between the components of their meal and the macronutrients best at creating cellular respiration.

Make connections to the Essential Question:

- Ask: Which macronutrient is best at creating fast reactants for cellular respiration? Why?
- Ask: Does the difference in the foods you consume throughout the year affect your overall weight? Can this help us answer the Essential Question?
    - Scholars should make connections between the way different macronutrients are processed in the body for use and storage to what happens to the 2,000 lb of food they eat. They should be able to state that some of the food they eat is used for

cellular respiration to create energy, as storage (in fat or glycogen) for later use or buildup, and to repair/aid muscles.

Make broader connections:

- Ask: What do you think happens when the body has more energy than it needs?
    - How do the different macronutrients create stored energy in the body?

Accountability (Exit Ticket) Three basketball players were talking about the snacks they eat before practice. They each had different ideas about the food they needed to eat to give them the most energy for practice. This is what they said:

Noelle: "Pasta or bagels have a lot of carbohydrates, so they will give me quick energy for practice."

Josiah: "Chicken has a lot of protein, so it will give me lots of energy before practice."

Alex: "Foods full of fat, like cheesy fries, are best for getting lots of energy right before practice."

1. Which player's statement is the most accurate? [1] Noelle
2. Explain why that player's statement is the most accurate. Support your response with your knowledge of science. [2]

Noelle is the most accurate because foods with many carbohydrates allow for quick digestion and storage of energy before a workout. Protein is more helpful after workouts to repair muscle damage, and fats take too long to digest before their energy can be used by the body.

3. Once the body uses food to create enough ATP for practice, what will happen to the extra macronutrients left over? [1]
    1. They will be used immediately to create extra ATP that is stored in the blood.
    2. They will be eliminated from the body as waste.
    3. They will be stored in the body until ATP is needed.
    4. The body will send a signal to the cells to stop producing ATP.

Scoring Award points as follows:

1. Award one point for stating that Noelle is the most accurate.
2. Award one point for each of the following:
    - A clear claim that identifies that foods rich in carbohydrates provide more energy for a workout
    - Specific evidence from their research that supports how that food provides energy to the body or why the other macronutrients do not benefit the body for a workout
3. Award one point for selecting answer choice C.

Lesson 10: My Burger Story (Two Days)

Lesson Objective: Scholars understand how the complementary nature of cellular respiration and photosynthesis provide the necessary essential resources that allow organisms to cycle matter and energy throughout their bodies. Materials Needed

- For the teacher and each scholar: a copy of the **Burger Story Rubric**
- For each group: colored pencils, rulers, fine-point markers

[**Engagement Tip:** Scholars can also create their comic strips digitally using **this** exemplar as an example.]

Prep

- Intellectual Prep:
    - Create your own Burger Story and grade yourself against the rubric.

What are scholars doing in this lesson?

- 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 it's eaten.

Day One

Do Now

- Follow the **Do Now plan**.

Launch

- Show scholars your favorite comic strip or graphic novel.
    - Explain that they will be creating one over the next two days to creatively represent the process that changes the food we eat into energy for our cells!
    - Tell scholars they will create a comic strip called "My Burger Story" to imagine they are a big bite of burger traveling through the body. Ask:
        - What would you look like as you passed through each organ?
        - What is happening to you along the way?
        - What other biological systems might you need to include to understand what happens to your burger bite?
- Display and discuss the **rubric** that will be used to score their Burger Story.

Activity

- Working independently, scholars piece together information in their Lab Notebooks from throughout the unit to draft their Burger Story comic strip in pencil.
- As scholars are working, circulate to assess and identify any who are still struggling to understand the different components of the biological systems involved in cellular respiration.
    - Coach struggling scholars by having them create a flowchart or map of food as it passes through the body before constructing their comic strip. Work with them to determine each detail in the map by having them go back to their Lab Notebook to find more information.

Discourse Debrief activity:

- Show one scholar's Burger Story and ask the class to provide feedback, using the **rubric** to support their assessment of the scholar's work.
    - Scholars may be missing important biological processes outside of the digestive system in their comic strip. Push scholars to use the rubric to assess the completion of their work.
    - Once scholars have assessed the sample work, give them 2–3 minutes to review a peer's work and give feedback based on the discussion. Have scholars review their new feedback and share their takeaways with the class.
        - Ask: What are you going to change in your Burger Story when you finalize your comic strip tomorrow? Why?

Make connections to the Essential Question:

- Ask: What parts of your Burger Story can help us answer the Essential Question?
    - Scholars should be able to articulate that the breakdown of food into smaller molecules, the elimination of waste from the body, the transformation of glucose into ATP (even smaller molecules) through cellular respiration, and the use of energy throughout basic bodily functions or exercise are crucial in understanding why we do not weigh 2,000 lb even if we consume that much food within the year.

Accountability (Exit Ticket)

1. Compose an answer to the Essential Question: <u>If the average human consumes 2,000 lb of food each year, why don't we weigh 2,000 lb?</u> Include a detailed explanation with at least three pieces of evidence from the unit and your knowledge of science to support and justify your response. [5]

Humans do not weigh 2,000 lb if they eat 2,000 lb each year because we break down food into smaller nutrients that are used and released from the body as energy or as waste. During digestion, food is broken down into smaller pieces through mechanical breakdown and later broken down with acid into specific nutrients through chemical breakdown. Once the nutrients are broken down, they are absorbed into the circulatory system and taken to all cells of the body by the unidirectional flow of blood. The rest of the food digested is eliminated from the body as waste. When the nutrients reach the cell and the mitochondria, the cell performs cellular respiration with the addition of oxygen from the respiratory system to create usable energy, ATP. The muscular system uses ATP to complete basic body functions like movement through muscle contraction. When people exercise, they use even more energy than usual. Any waste from cellular respiration and organs are released back into the circulatory system and later

eliminated from the body. The 2,000 lb of food we consume is both broken down into smaller pieces to use as energy for the body and eliminated from the body completely. This allows humans to maintain their overall weight.

Scoring Award points as follows:

1. Award one point for each of the following:

    - A clear claim that identifies a reason why we do not weigh 2,000 lb based on the information learned throughout the unit
    - Supporting evidence from the unit that explains how the biological processes of the body break down food, use energy, and/or eliminate waste (up to three points)
    - Justification/reasoning that further explains how the biological processes outlined in the evidence tie back to their claim

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Day Two

Do Now

- Follow the **Do Now plan**.

Launch

- Have scholars review their comic strip drafts and feedback from yesterday for 2–3 silent minutes to reorient themselves with their goals for today.
- Ask: Would your Burger Story change if your burger bite was traveling through an athlete compared to a nonathlete? Why or why not?
    - Scholars should recognize that the overall Burger Story would not change. They might think that potentially the speed in which the burger bite is processed might be faster because athletes need to create more energy through cellular respiration, but although this is true, the speed of digestion would not change.
- Today scholars complete the final drafts of their Burger Story and showcase their comic strips in a gallery walk at the end of class!

Activity

- Working independently, scholars finalize their Burger Story comic strip.
- As scholars are working, circulate to assess and identify any who are still struggling to clearly articulate their ideas through picture and text.
    - Coach struggling scholars by having them talk through what they are trying to represent in the drawing and in the text.
        - If scholars are having trouble drawing what each part of the body looks like, encourage them to use more text to describe their picture if they think it will not be clear enough.

        - If scholars struggle to create the text from their drawing, encourage them to describe what their picture represents verbally, one sentence at a time. After each sentence, have the scholars write out what they said. Continue this process until they have fully described their picture. Have the scholars use this as a basis for the text they will use to accompany their picture.

Discourse Debrief activity:

- Set up a gallery walk of their Burger Story comic strips throughout the classroom.
    - Ask scholars to notice similarities and differences between their Burger Story and the ones their peers made.
    - Have scholars record questions they have for other scholars about their Burger Stories.
- Discuss the similarities and differences between the different comic strips throughout the room.
    - Do these differences mean someone's Burger Story is scientifically inaccurate? Is there more than one way to represent this information? How?

Make connections to the Essential Question:

- Ask: What would happen to their burger bite if you eliminated sunlight from the story?
- Ask: What would happen if we eliminated the respiratory system from the story?

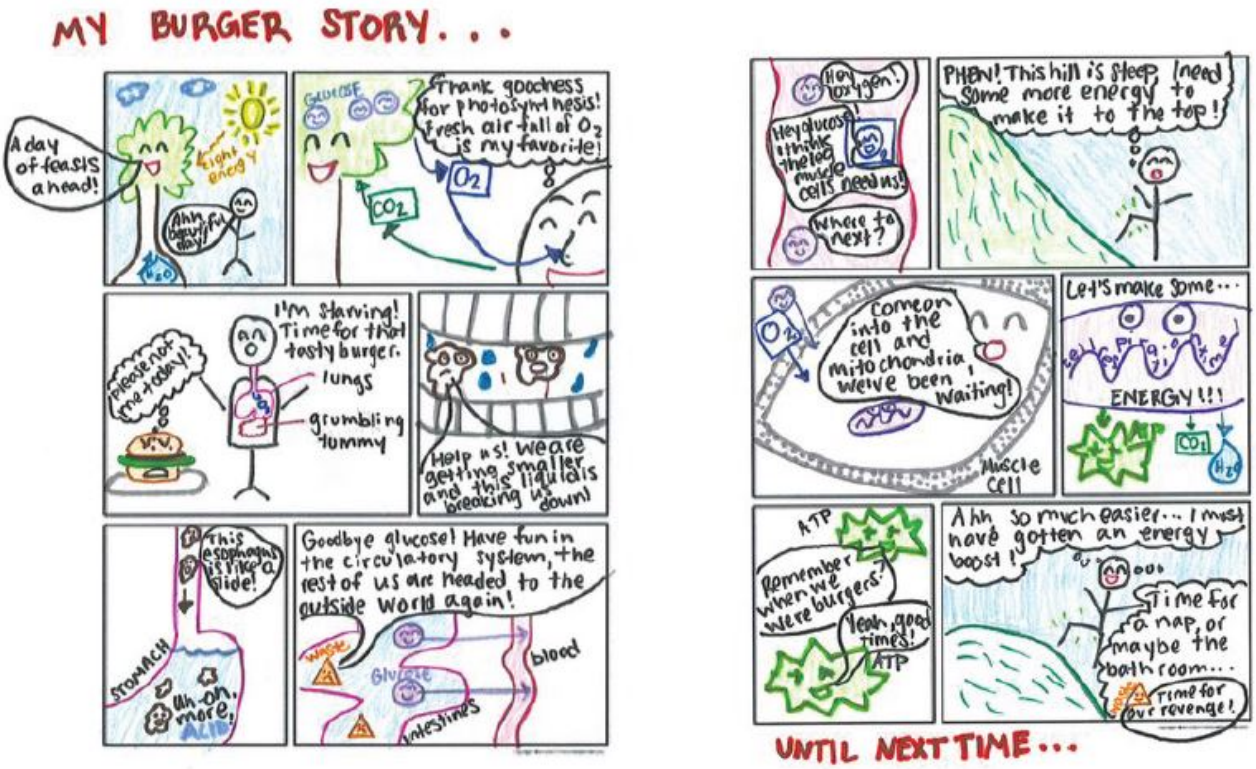
Make broader connections:

- Ask: Would these comic strips still be accurate if they were about a cookie instead of a burger? Why?
    - With true understanding of the Big Ideas from the unit, scholars should be able to apply what they know about biological processes to understand what would happen to the burger bite in different scenarios.

Accountability (Classwork)

- Grade scholar completion of their Burger Story from their classwork.

Exemplar:



Scoring Award points as follows:

- Use the Burger Story **rubric** to grade each scholar's final version of their comic strip.

Unit Vocabulary

Vocabulary List

- **glucose**
- **oxygen**
- **chlorophyll**
- **carbon dioxide**
- **photosynthesis**
- **chloroplasts**
- **chemical equation**
- **reactant**
- **product**
- **by-product**
- **digestive system**
- **mechanical breakdown**
- **chemical breakdown**
- **respiratory system**

- **circulatory system**
- **unidirectional**
- **ATP**
- **mitochondria**
- **muscular system**
- **cellular respiration**
- **macronutrients**
- **stored energy**
- **basal metabolic rate (BMR)**