SUCCESS ACADEMY EDUCATION INSTITUTE

Life Science:
Unit 1

The Secret Lives of Cells: Lessons

Lesson 1: The Stuff of Life

Lesson Objective: Scholars question the composition of living things and think about where the tissue that heals our cuts comes from. They wonder how it is possible that new skin just seems to "appear" when we need it. Materials Needed

- For each group: 2 scarred fruits, deli tray or paper plate, plastic butter knife

Prep

- Materials Prep:
    - Go to the grocery store to get the fruit for this lesson.
        - Purchase fruits that are visibly scarred for scholars to observe. Fruits with smooth, thin peels like apples and pears will work best.
- Intellectual Prep:
    - Read **The Cells in Your Body** to review the science of cells.

What are scholars doing in this lesson?

- Scholars study scarred fruits and consider their own scars. How can bodies heal themselves? They share their predictions about this phenomenon and their ideas for finding an answer.

Do Now

- Follow the **Do Now plan**.

Launch

- Ask scholars: What do you think living things are made of?
    - As scholars respond, press them to think on an even more micro scale. If they say skin, bones, and muscles, ask them what skin and bones are made of."
        - Scholars may mention molecules, as they know these small particles from other science units. If they do, remind them that water is made of molecules too. What do they think makes living things unique?
- Tell a quick, engaging story about a time when you got a paper cut. Ask:
    - What happens when you get a paper cut? What about the next day?
- Introduce today's lab:
    - Examine injured fruit.
    - Predict and discuss how the fruits healed.
    - Make a fresh cut in the fruit to see if we can observe the healing process in action.
- Ask: What do you expect to see when we compare the fresh cuts on the fruits to the healed cuts?
    - Scholars record their predictions in their Lab Notebooks.

Activity

- Scholars work in groups to examine the fruits.
    - Each group studies a set of two fruits and records their observations.
- Scholars discuss what will happen when they cut each fruit.
    - Scholars make one fresh cut in each fruit.
    - Scholars record their observations and compare the fresh and healing cuts.
- Scholars discuss the following questions as a group:
    - How were the fresh cuts different from the healing ones? Did you observe any changes in the freshly cut area throughout the lesson?

        - What do you predict the fresh cut will look like in a week? Why?
            - Do you think there would be a difference between a fruit that is still on the tree versus a fruit that has been removed from the tree, like the ones we have in the lab? Why?

- Scholars record an initial explanation of how they think cuts and other injuries heal.
- As scholars are working, circulate and listen for explanations that should be highlighted during the Discourse.

[**Tip:** Allow extra time for cleanup, as scholars may need to wipe down their tables!]

Discourse Debrief activity:

- Scholars share and discuss their initial explanations of how cuts and other injuries heal as a class.
    - Scholars should conclude that something causes new tissue to form to heal a cut, but they will not know what it is yet. Allow them to share their ideas about this mysterious something and how it gets there.
    - If scholars mention bandages or gauze, ask them what they think the purpose of the bandages is. Are they there to heal the cut? If so, why don't we see a skin-like or glue-like material on them? Support scholars in reaching the conclusion that bandages are there to protect the open wound, not to actually seal it up.

Introduce the Essential Question:

- Introduce the unit's Essential Question: What are living things made of?
    - Explain to scholars that the answer to this question is foundational to their study of biology, which will continue throughout middle and high school, and that answering this question will take them to places they never knew existed!
    - Allow scholars to share their initial predictions. Chart these responses and return to evaluate them later in the unit.

Accountability (Lab Notebook)

- Scholars write initial explanations of how they think cuts and other injuries heal.

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 contentâ€" rate them on effort and writing.
    - Look for the following when scoring scholar responses:
        - A clear claim that answers the question

- Specific evidence collected from the activity or their prior knowledge that supports the claim
- Justification/reasoning that ties the evidence to the claim
- High effort shown in writing, with complete sentences and proper grammar/ punctuation seen throughout the response

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Lesson 2: A Closer Look (Three Days)

Lesson Objective: Scholars *discover cells*! Using the microscope, they discover that all living things are composed of these tiny building blocks. After they observe two different types of animal cells, scholars start to notice their similarities and differences.

Materials Needed

- For the teacher: 2 different sample scientific drawings, each missing some components (teacher-created)
- For each group: assorted small, flat objects to study under the microscope, 1 prepared slide of cheek cells, 1 prepared slide of Amphiuma liver, 2 index cards
- For each scholar: microscope (1 per pair of scholars), **Scientific Drawing Tips and Rubric**

[**Materials Tip:** If you don't have many microscopes for this lesson, consider using an online microscope such as the **UD Virtual Compound Microscope** from the University of Delaware (**CC BY-NC-ND 2.5**) to reach the same lesson objectives.]

Prep

- Materials Prep:
    - If time allows, consider providing the materials for scholars to create their own cheek slides during this lesson.
- Intellectual Prep:
    - Review the **Animal and Plant Cells Handout** to familiarize yourself with the structures scholars will be observing. Note: Scholars will not receive this handout until a later lesson.

What are scholars doing in this lesson?

- Scholars learn to use a microscope and see cells under the microscope for the first time (though they do not know what they are seeing yet). By the end of this three-day lesson, scholars will know they have discovered cells and will have begun to develop basic diagramming skills.

Day 1

Do Now

- Follow the **Do Now plan**.

Launch

- Discuss:
    - Do you think we would be able to see what heals our cuts if we could “zoom in” on them? Why?
    - How might finding the answer help us get closer to answering the unit’s Essential Question?
- Introduce the lesson:
    - You will observe two different samples taken from animals: small, thin scrapings from a person’s cheek and the liver of an aquatic salamander.
    - To do this, you will need to learn to use a new tool: a **microscope!**
- Demonstrate for scholars only what is necessary to ensure they use the microscope safely. (This may vary depending on your microscope, but generally this will include proper use of any fragile/glass parts and the power cable.)
- Challenge scholars to discover how the microscope works on their own.
    - Explain that they will be given materials to use as they explore the microscope and that they should jot down their findings on a diagram in their Lab Notebook as they work.

Activity [**Materials Management Tip:** Encourage scholars to keep their experimental slides on an index card when not in use to prevent accidental breakage.]

- Scholars work in partnerships to explore with the microscopes.
    - Provide scholars with small, relatively flat objects to examine under the microscope, such as magazine clippings (color is best), pencils with sharp points, or coins.
- Scholars jot down their findings in their Lab Notebook.
- Scholars discuss the following questions as a group:
    - What does each part of the microscope do?
    - How should we use the microscope to help us examine the biological samples?
- As scholars are working, circulate and help any who are struggling to troubleshoot.

[**Tip:** This guide provides suggested pacing, but if you are confident that scholars are ready to examine the biological samples on day one, modify your plans accordingly!]

Discourse Debrief activity:

- Put a diagram like the one in scholars' Lab Notebooks up on a viewable screen.
    - Go through the parts one by one and ask scholars to share their discoveries. As each part of the microscope is described, name it and have all scholars label it in their Lab Notebook. (For reference, see **Compound Microscope Parts** diagram.)

Make connections to the Essential Question:

- Ask: How will the microscope help us to answer the unit's Essential Question?
- Ask: What do you think we will see when we study the biological samples under the microscope?

Make broader connections:

- Break down the word microscope into its parts.
    - Ask: Where have you heard "micro-" before? What do you think "micro-" means?
    - Ask: Where have you heard "-scope" before? What do you think "-scope" means?

Accountability (Informal)

- As scholars are working, take note of the groups who are struggling to learn to use a microscope. Plan to circulate back to them first on day two to provide extra support.

Day Two

Do Now

- Follow the **Do Now plan**.

Launch

- Introduce today's lab:
    - Now that you have begun to learn some microscope basics, you will dive in and observe two different samples taken from animals: small, thin scrapings from a person's cheek and the liver of an aquatic salamander (show a **photo**).
- Elicit from scholars the main features of a scientific drawing. Chart these so scholars can easily reference them during the lesson, and allow scholars to record them in their Lab Notebooks. Include:
    - Ensure that the drawing is large enough to be clearly visible.
    - Draw only what you see.

    - Title your drawing.
    - Draw neat, straight label lines.
    - Ensure label lines point to the center of the structure being labeled.
    - Print all labels horizontally.
    - Include magnification (if a microscopic drawing) or a scale (if a macroscopic drawing).

- Practice evaluating a sample diagram together using the list created by the class.

Activity [**Materials Management Tip:** Encourage scholars to keep their experimental slides on an index card when not in use to prevent accidental breakage.]

- Scholars work in partnerships to examine the biological samples.
- Scholars diagram their findings in their Lab Notebook. (Provide part or all of the content within the **Scientific Drawing Tips and Rubric** to support scholars, but do not coach them on how to use it yet.)
- Scholars discuss the following questions as a group:
    - What did you see under the microscope?
    - Compare and contrast the liver sample with the cheek sample. What did they have in common? What makes them different?
    - Why is creating diagrams of your findings useful? Why might scientists create visuals to share their observations instead of taking written notes?
- As scholars are working, circulate and press scholars to include details and purposeful labels in their diagrams.

Discourse Debrief activity:

- Share two or three sample diagrams that are in progress under the document camera. Ask the scholars to describe their diagrams and explain what they observed when zooming in on the liver and cheek samples.
    - When scholars describe **cells**, introduce and define the term. Do not go overboard with details at this timeâ€" scholars will discover much more about cells throughout the course of the unit.
    - Allow the class to evaluate the sample diagrams. Ask that they include both praise and constructive criticism based on the list of characteristics of a scientific diagram that you developed during the Launch and the information from the provided handout.

Make connections to the Essential Question:

- Ask: What is your initial answer to the Essential Question? What more do we still need to learn to be able to provide a thorough answer?

Accountability (Informal)

- As scholars discuss and evaluate their diagrams during the Discourse, listen for misconceptions related to scientific diagrams or microscope use. Make a plan to strategically address these issues using the “Do Now” time on day three.

Day Three

Do Now

- Follow the **Do Now plan**.

Launch

- Ground scholars in their work by reminding them of the unit’s Essential Question. Ask: What do we know so far?
- Complete a quick review of the expectations for scholar diagrams. Refer scholars back to the chart you created on day one outlining the main features of a scientific drawing.
- Display a sample diagram. Allow scholars to evaluate the diagram in partnerships and then share with the class.
    - Answer any lingering questions before scholars begin working.

Activity [**Tip:** Encourage scholars to keep their experimental slides on an index card when not in use to prevent accidental breakage.]

- Scholars continue to examine the biological samples and diagram their findings in their Lab Notebook.
- Scholars discuss the following questions as a group:
    - What do you see under the microscope?
    - Compare and contrast the liver sample with the cheek sample. What did they have in common? What makes them different?
    - Why is creating diagrams of your findings useful? Why might scientists create visuals to share their observations instead of taking written notes?
- As scholars are working, circulate and ask them to evaluate their work against the class-created chart.

Discourse Debrief activity:

- Share an exemplar diagram under the document camera. Ask the scholar to describe their diagram and explain what they observed.
    - Ask the class to identify the qualities of the diagram that make it a strong exemplar model.
    - Ask scholars to explain why clear, high-quality diagrams are so important to scientists.

- Scholars explain what the animal cells they observed have in common. Ask:
    - What do you think the functions of the structures you observed might be?
    - Were the cells organized in any way? Why do you think that is?

Make connections to the Essential Question:

- Ask: Based on what you have seen using the microscopes, how would you currently answer the unit's Essential Question? Explain.

Make broader connections:

- Explain that cells are very tiny. They are so tiny, in fact, that our bodies are composed of trillions of cells. (Write the number one trillion in numerals so scholars can see how large it is!)
- Organisms obviously vary in size, but even the tiniest living things are made of cells!
    - Introduce and define **unicellular** and **multicellular**.
        - Ask: Can you think of an example of an organism that might be unicellular?
        - Scholars will likely mention microbes. If they do, share that many microbes are unicellular, including bacteria!
        - Show the following image of a unicellular organism under the microscope:

Image credit: "Blepharisma japonicum, Heterotrichea, Ciliophora" by **Frank Fox** (**CC BY-SA 3.0 de**) via Wikimedia Commons.

[**Engagement Tip:** If time allows, show other examples of animal cells on the SMART Board. Allow scholars to guess where the cells came from before you reveal the answer.]

Accountability (Lab Notebook)

- Score one diagram from each scholar's classwork that reflects the scholar's best effort.

[**Materials Management Tip:** Have scholars mark this diagram with a star and leave their Lab Notebook open to the page for easier grading!]

Scoring Award points as follows:

- Award up to four points for the drawing and up to four points for the formatting using the **Scientific Drawing Tips and Rubric**.
    - Note: Use the "levels" as points. If a scholar receives a Level 3 on the drawing and a Level 4 on the formatting, they would score seven points total out of eight possible points.

Lesson 3: Are All Cells the Same? (Two Days)

Lesson Objective: Scholars are able to identify that cells from different types of organisms differ in composition. They can vaguely describe their ideas about this at this point and may not know any specific organelles yet. Materials Needed

- For the teacher: 1 onion, 1 elodea plant, knife, 1 gallon of water, methylene blue, slides, coverslips, 1 pair of forceps, 1 dropper (if creating elodea leaf and onion slides)
- For each group: 2–3 slides containing plant cells for observation (can use premade cork, privet leaf, and onion slides or prepare slides of elodea leaf and/or onion epidermis), 2 index cards, **Scientific Drawing Tips and Rubric**
- For each scholar: microscope, safety goggles

Prep

- Materials Prep:
    - Optional, but recommended: Prepare onion and elodea slides using **these** instructions or use a flex day to allow scholars to create their own wet mounts!
- Intellectual Prep:
    - Review the **Animal and Plant Cells Handout** again to familiarize yourself with the structures scholars will be observing. Note: Scholars will not receive this handout until a later lesson.

What are scholars doing in this lesson?

- Scholars observe plant cells using the microscopes and compare and contrast them with the animal cells they observed in the previous lesson.

Day One

Do Now

- Follow the **Do Now plan**.

Launch

- Discuss:
    - Do you think that all cells look similar? Why or why not?
- Introduce today's lab:
    - You will observe and draw cells from different types of plants to determine their characteristics.
    - You will compare and contrast plant cells and animal cells.
- Before beginning, explain why slides are sometimes stained.

Activity [**Safety Tip:** If time allows, print instructions for scholars to prepare their own plant slides. Just ensure you complete the slicing that requires a sharper knife in advance, and that they know how to handle and use all of the materials safely.]

- Scholars work in pairs to examine plant cells.
    - Partners observe the cells and diagram their findings in their Lab Notebook.
- Scholars create a Venn diagram to compare and contrast plant and animal cells.
- As scholars are working, circulate and press them to implement their takeaways and feedback from the last lesson's diagrams to improve their work.

Discourse Debrief activity:

- Share two or three sample diagrams that are in progress under the document camera. Ask the scholars to describe their diagrams and explain what they observed when zooming in on the liver and cheek samples.
    - Allow the class to evaluate the sample diagrams. Ask that they include both praise and constructive criticism based on the list of characteristics of a scientific diagram that you developed during the Launch.

Make connections to the Essential Question:

- Ask: Do your findings today change anything about your answer to the unit's Essential Question? Explain.
- Ask: How do the plant and animal cells you have observed so far differ from the coin/other nonliving object you observed on the first day using the microscopes?
    - Do you think nonliving things are composed of cells too? What's your evidence?

Make broader connections:

- Ask: What do all plant cells seem to have in common?

Accountability (Informal)

- As scholars discuss and evaluate their diagrams during the Discourse, listen for misconceptions related to cells, scientific diagrams, or microscope use. Make a plan to strategically address these issues on day two.

Day Two

Do Now

- Follow the **Do Now plan**.

Launch

- Explain to scholars that they will continue their work observing plant cells and creating scientific diagrams to share their findings.
- Before the class begins working, take a few minutes if needed to address a common misconception or error that you have observed among many of the scholars.

Activity

- Scholars continue their work in pairs to examine plant cells.
    - Partnerships observe the cells and diagram their findings in their Lab Notebook.
- Scholars create a Venn diagram to compare and contrast plant and animal cells.
- As scholars are working, circulate and press them to implement yesterday's feedback to improve their diagrams.

Discourse Debrief activity:

- Ask: What do all plant cells seem to have in common?

- Scholars add to a Venn diagram as a class, comparing plant and animal cells.
    - Why might plant cells and animal cells look different?
    - What do all cells seem to have in common?

[**Tip:** While you should not formally introduce all of the organelles yet, it's fine to name those that scholars identify or describe. The idea is not to withhold all information but rather to let scholars first explore and describe what they see in their own words.]

Make connections to the Essential Question:

- Ask: How does this new information get us closer to answering our Essential Question? What additional information is still needed?

Make broader connections:

- Show an image of a leaf under a microscope. Discuss why so many plant cells are green, and allow scholars to draw connections to what they learned about photosynthesis in elementary school.

Accountability (Exit Ticket) Directions: Use the image below to answer the question.

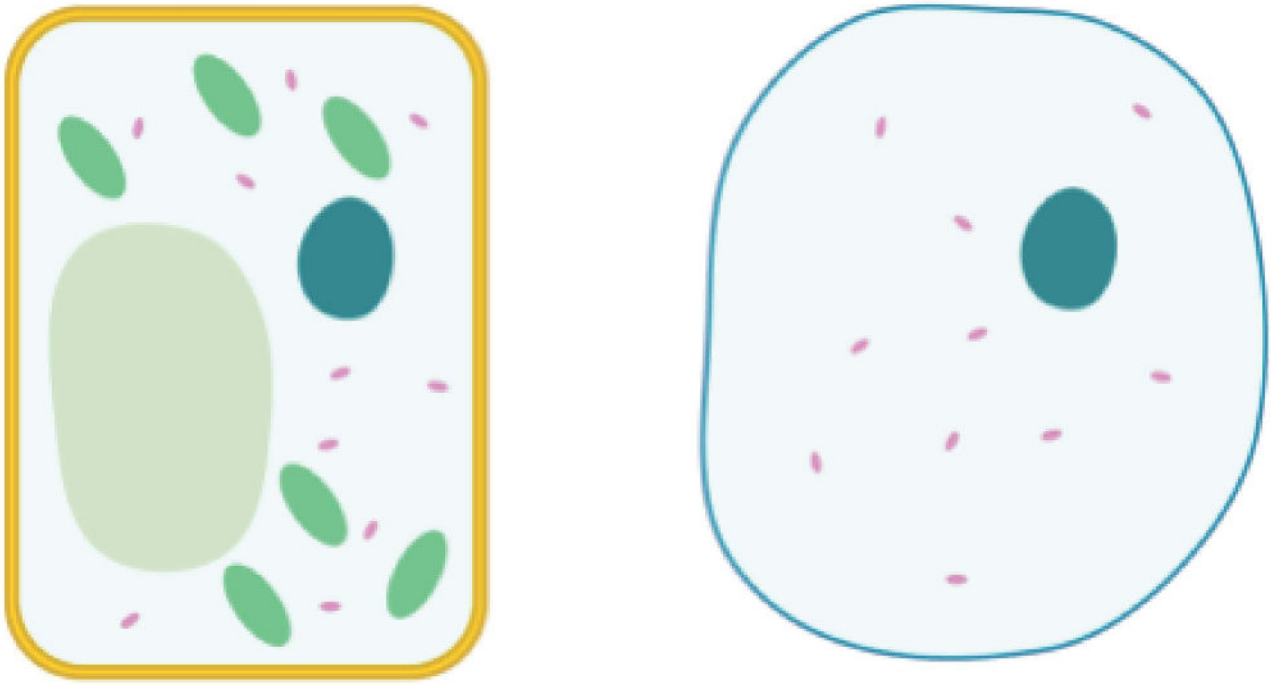
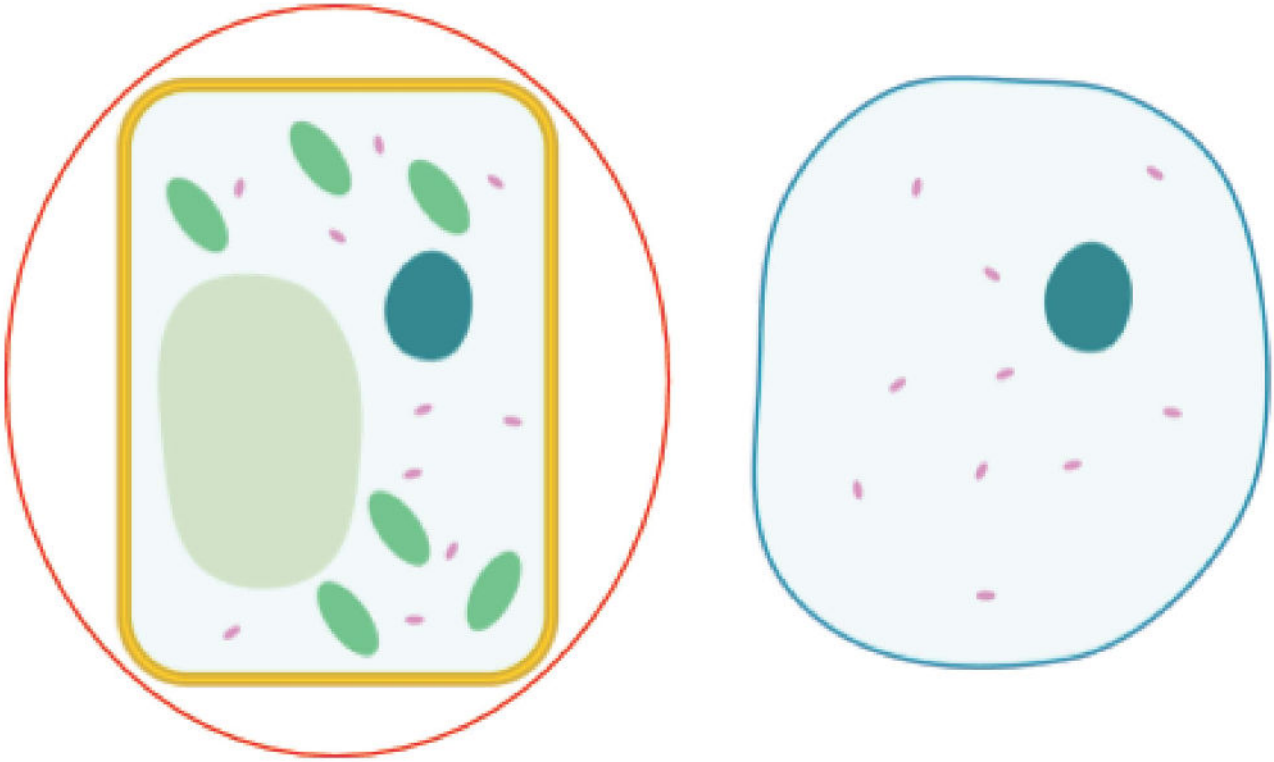


Image credit: Adapted from **domdomegg**, **CC BY 4.0** via Wikimedia Commons.

1. Circle the image above that is most likely a plant cell. [1]



2. Why do you think it is a plant cell? Explain your reasoning. [2]

I think the cell on the left is a plant cell because of its shape. In class, the elodea and onion cells had a more rectangular shape, but the animal cells were more rounded.

Scoring Award points as follows:

1. Award one point for selecting the cell on the left.
2. Award one point for each of the following:

    - One piece of evidence that identifies the cell on the left as a plant cell (Note: Scholars will likely lack the specific vocabulary to describe this precisely yet.)
    - Justification/reasoning that explains the evidence (will likely tie back to the lesson)

Lesson 4: The Parts of a Cell (Two Days)

Lesson Objective: Cells contain several different organelles that each serve an important role. Cells are differentiated to perform particular functions, and this results in differences between the cells found in different types of organisms (such as plants vs. animals). Scholars are able to identify and describe several organelles, including the nucleus, mitochondria, cell membrane, cell wall, chloroplasts, vacuole, and cytoplasm. Materials Needed

- For the teacher: the Sheppard Software **Animal Cell** and **Plant Cell** activities (to email to scholars)
- For each scholar: a copy of the **Animal and Plant Cells Handout**, computer/device

Prep

- Materials Prep:
    - Email the Sheppard Software **Animal Cell** and **Plant Cell** activity links to scholars.
    - Make copies of the **Animal and Plant Cells Handout**.
- Intellectual Prep:
    - Read **Cellular Organelles and Structure** from Khan Academy to review the functions of organelles.

What are scholars doing in this lesson?

- Scholars conduct research and complete readings to learn more about the parts of a cell and their functions.

Day One

Do Now

- Follow the **Do Now plan**.

Launch

- Ask: What makes up a cell? How do you know?
    - Scholars should reference their diagrams from the previous lessons. They may not know the names of any organelles yet, but they should be able to tell you that cells are made up of distinct parts.
    - Explain that to produce a detailed answer to our Essential Question, scholars will need to find out more about the parts of a cell and their functions. In this two-day lesson, they will have the opportunity to do just that!
        - Explain that **organelles** are the small structures within the cell that carry out specific functions. As many scholars already suspected, plants and animals share some organelles, while others are unique to a certain type of cell.
- Introduce the two-day lesson:
    - Scholars will explore online models of cell structures to discover their functions.
    - They will gather additional evidence to compare and contrast plant and animal cells.
    - Then they will use the information from the handout and websites to update their earlier diagrams to identify the structures they observed.

Activity

- Scholars view the Sheppard Software **Animal Cell** and **Plant Cell** activity tutorials.

[**Tip:** If the tutorials do not load, instruct scholars to click the little *i* in the circle, click “site settings,” scroll down to Flash, and click “allow.” When they return to the tab with the interactive, it should be working.]

[**Tip:** Have scholars complete revisions and updates in a different color so you can easily see their work and provide feedback.]

- Scholars complete a chart in their Lab Notebooks with the function of each organelle.
- Scholars discuss the questions as a group:
    - How do cells protect themselves?
    - How do cells get energy? Why do they need energy?
    - What other functions do cell structures carry out? Why?

Discourse Debrief activity:

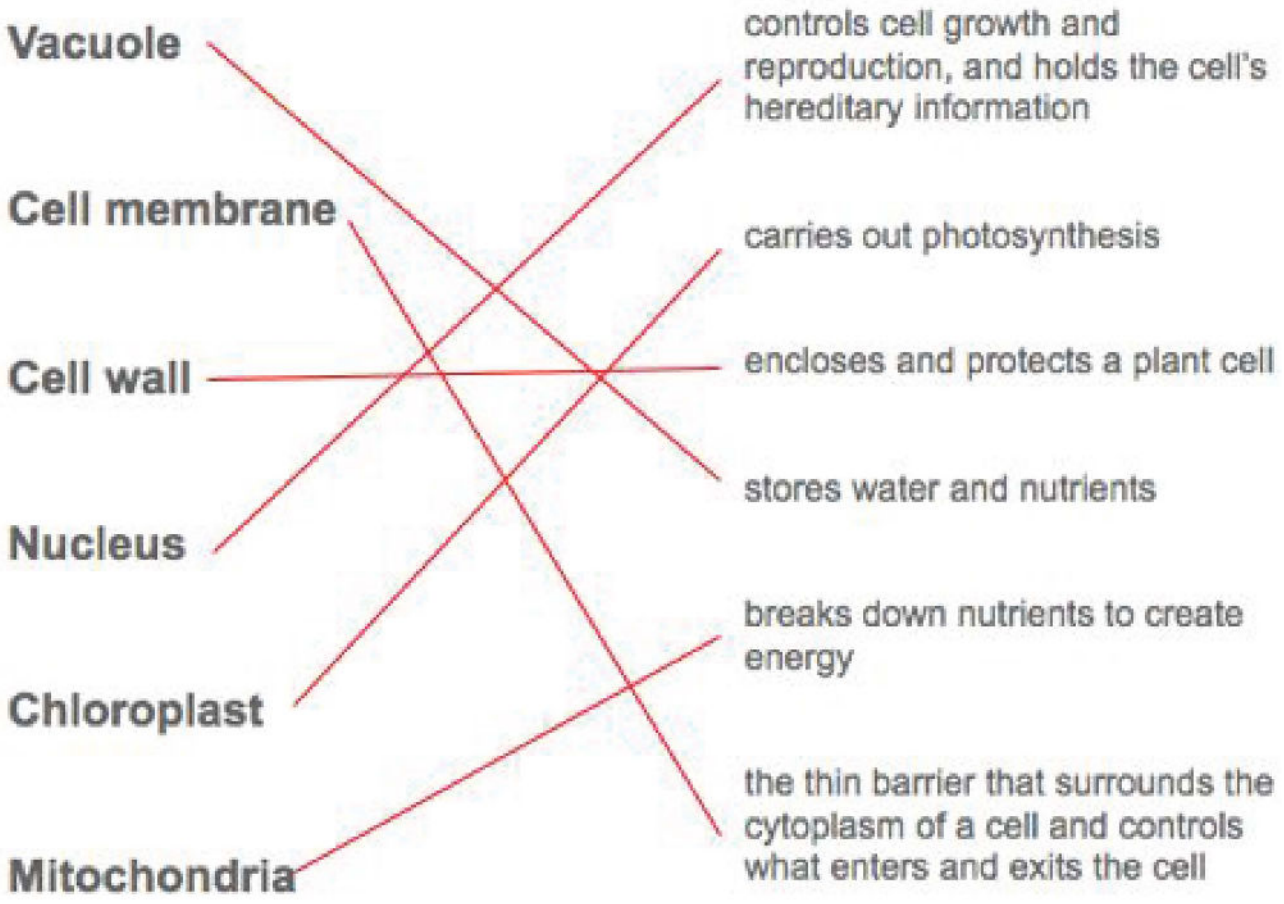
- Ask: Which organelles are common to both plants and animals? Which ones are not?
    - Ensure that scholars know the following organelles: **nucleus**, **mitochondria**, **cytoplasm**, **vacuole**, **cell membrane**, **cell wall**, and **chloroplast**.
- Ask: Why do plants and animals have different organelles?
    - Ensure that scholars have a surface-level understanding that cells can specialize to meet the needs of an organism.
- Ask: What are some of the functions that individual organelles need to carry out to help a cell survive? Why?
- Review the discussion questions from the activity.

Make connections to the Essential Question:

- Connect this information back to the Essential Question. Ask: How does this help you further understand what we’re made of?

Accountability (Exit Ticket)

1. Draw lines to match each organelle with its function. [3]



Scoring Award points as follows:

1. Award points based on the number of correct responses:
    - Three points for six correct responses
    - Two points for four to five correct responses
    - One point for two to three correct responses
    - Zero points for less than two correct responses

Day Two

Do Now

- Follow the **Do Now plan**.

Launch

- Remind scholars of the structure of the two-day lesson (this will be helpful for all scholars to hear, as they may have ended in different places after the first day):
    - Scholars will explore online models of cell organelles to discover their functions.
    - They will gather additional evidence to compare and contrast plant and animal cells.

    - Then they will use the information from the handout and websites to update their earlier diagrams to identify the structures they observed.

Activity

- Scholars who did not finish on the first day continue to work with the **Animal Cell** and **Plant Cell** activity tutorials.

[**Tip:** Have scholars complete revisions and updates in a different color so you can easily see their work and provide feedback.]

- Scholars complete a chart in their Lab Notebooks with the function of each organelle.
- Scholars discuss the questions as a group, if they have not already:
    - How do cells protect themselves?
    - How do cells get energy? Why do they need energy?
    - What other functions do cells carry out? Why?
- Once the above is complete, scholars use the tutorials and the **Animal and Plant Cells Handout** to refine their drawings from lessons 2 and 3.

Note: Scholars should add appropriate labels but not manipulate the actual drawing to include things they did not observe. Scholars will notice that some of the organelles appear to be “missing”â€” encourage them to discuss this issue as a group and to raise it during the Discourse.

Discourse Debrief activity:

- If you did not cover this thoroughly on the first day, ask: Which organelles are common to both plants and animals? Which ones are not?
    - Ensure scholars know the following organelles: **nucleus**, **mitochondria**, **cytoplasm**, **vacuole**, **cell membrane**, **cell wall**, and **chloroplast**.
- Review the discussion questions from the activity if you did not complete this on day one.
- Raise the issue identified during the activityâ€” several of the organelles that the website states are present in plant or animal cells seem to be “missing” from scholars’ diagrams. Does this mean that the cells we observed only contain a small number of organelles?
    - Allow scholars to share their ideas, then explain to scholars why many organelles may not have been visible to them.

Make connections to the Essential Question:

- Ask: How does this new information help you further understand what living things are made of?

Make broader connections:

- Ask: Why do plants and animals have different organelles?
    - Ensure that scholars have a surface-level understanding that cells can specialize to meet the needs of an organism and are able to name a few differences between plant and animal cells.

Accountability (Exit Ticket)

1. Why do plant and animal cells contain unique structures? Explain your response using specific evidence from today's class. [3]

Plant and animal cells contain unique structures because they have different needs. For example, plants need to perform photosynthesis but animals do not. Because of this, plant cells contain chloroplasts but animal cells do not.

Scoring Award points as follows:

1. Award one point for each of the following:
    - A response that identifies one reason why plant and animal cells have unique structures
    - An explanation that demonstrates understanding of their response and includes specific, scientifically accurate evidence from class

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Lesson 5: What Is a System?

Lesson Objective: A cell is a system composed of several parts with unique but essential functions. This conceptual understanding of systems helps scholars prepare for Lesson 6, in which they explore the many interacting subsystems present in complex organisms. Materials Needed

- For each group: radio, screwdriver set, tray
- For each scholar: copy of dissection procedure, goggles

Prep

- Materials Prep:
    - Develop a dissection procedure for scholars to follow as they dismantle a radio to learn about its parts. Print copies for each scholar.
        - Consider the order of the procedure you create. Allow scholars to experiment with nonessential parts before cutting any wires or doing irreparable damage. The goal is for them to discover that some parts of the radio (like the battery cover) are simply very helpful, while others (like the battery) are absolutely essential to the functioning of the whole system.

- Intellectual Prep:
    - Read this **Tools for Systems Thinkers: Getting into Systems Dynamics...and Bathtubs article** to intellectually prepare to teach scholars about systems.

What are scholars doing in this lesson?

- Scholars dissect a radio to learn about the concept of a system. They then draw comparisons between the radio and a cell.

Do Now

- Follow the **Do Now plan**.

Launch

- Ask the question posed by Draper L. Kauffman Jr. (referenced in the intellectual prep article): If you cut a cow in half, do you have two cows?
    - Press scholars to explain their reasoning. The goal is to get them thinking about how some things need a certain set of parts or organization to function.
- Ask: What about if you cut a ball of clay in half? Could you get two balls of clay from it?
    - How is this different from the cow?
- Explain that the parts of the cow form a **system**. Today scholars will study another exampleâ€" a radioâ€" to learn more about what makes systems unique. Then they will discuss how this applies to cells.

Activity

- Scholars dissect a radio using the provided procedure to discover its parts and their functions.
- As scholars are working, circulate and ask:
    - How do you know which parts are essential for the whole object to function?
    - Which parts can the radio function without? Why, then, are they there at all?
    - How do you know that a radio is a system?
    - What do you think a radio and a cell have in common? Do you think a cell is a system? Why?

Discourse Debrief activity:

- Discuss the questions from the activity.
- Ask scholars to explain how they know that a radio is a system.

Make broader connections:

- Ask scholars if they can think of any other systems. (One common example they are all familiar with is a food web.)
- Return to the statement made during the Launchâ€" is a cell a system too?
    - Ask: What does this tell you about cells?
        - Scholars should predict that cells contain structures that work together to perform functions.
        - Scholars may ask whether groups of cells are part of larger systems. Confirm that they are, and that scholars will learn more about that later in the unit.
- Ask: What might happen if you removed some of the parts from a cell? Why?
    - Like the radio, a cell has certain parts that are essential to its functioning. There are others, however, that can be damaged without immediately causing the cell to die. Cells can compensate for certain compromised or abnormal parts, but this often makes them much more vulnerable to injury or malfunction.

Accountability (Lab Notebook â€" Informal)

1. Have scholars go back to their Lab Notebooks and revise their answer for question 3, “How do you know that a radio is a system?”
    - Assess scholars’ conceptual understanding of systems based on their revisions to question 3 after Discourse.
2. Ask scholars to add to or revise their initial explanation of “How do you think cuts and injuries heal?” in their Lab Notebooks based on class discussion and new ideas formulated from lessons 2–4.

Scoring Award points as follows:

1. Score scholars on a 1–4 scale (below expectations through exceeding expectations) based on classwork.
    - Look for the following when scoring scholar responses:
        - A clear claim that answers the question
        - Specific evidence collected from the activity or their prior knowledge that supports the claim
        - Justification/reasoning that ties the evidence to the claim
        - High effort shown in writing, with complete sentences and proper grammar/ punctuation throughout the response
2. Do not score their new responses. Study scholar responses for evidence of new understandings and any misconceptions.

Lesson 6: The Organization of Cells

Lesson Objective: Cells are organized and specialized to optimize their performance. Scholars are able to explain and order various levels of organization (cell, tissue, organ, organ system, organism) according to their complexity. They understand (on a surface level) that cells divide for growth, repair, and reproduction and that all cells come from preexisting cells. Materials Needed

- For each group: onion, forceps, prepared onion slide, microscope, toothpicks, materials to make onion epidermis slides (optional)

[**Tip:** Refrigerate onions to help reduce tears for sensitive eyes.]

Prep

- Intellectual Prep:
    - Watch the **Levels of Organization video** (2 minutes, 30 seconds) to review cellular organization.

What are scholars doing in this lesson?

- Scholars dissect an onion to learn more about the levels of cellular organization within a complex organism.

Do Now

- Follow the **Do Now plan**.

Launch

- Show a photo of a person's face. Ask:
    - If the parts of this person's face are made from animal cells, why do they all look so different?
    - Do you think the cells that make up our bodies are organized in any particular way? If so, how?
        - Chart scholar responses but do not confirm or deny their accuracy yet.
- Explain that in this lesson, scholars will have the opportunity to take apart an onion to see if they can determine why it looks the way it does.

Activity

- Scholars use the available materials to dissect an onion to study how onion cells are organized.
    - They should take note of the levels of organization visible both through the microscope and with the naked eye as they dissect the onion bulb. They should also

notice how cells arrange into tissue of different shapes and sizes to form various parts of the onion.
    - Scholars diagram their findings.
    - If time allows, make available the materials for scholars to make their own slides to look at the onion under the microscope.

- Scholars should discuss with their table:

    - How is an onion organized?
    - How do cells come together to form larger structures?
    - How do plant cells form so many different-looking plants and plant parts? Why don't all vegetables, for example, look alike if they are all made from plant cells?

Discourse Debrief activity:

- Discuss the questions from the activity with the whole class.

    - Ensure scholars become familiar with the terms **cell**, **tissue**, **organ**, **organ system**, and **organism**. Have scholars order them from least to most complex in their Lab Notebook in the "Additional Notes" section.

Make broader connections:

- Show a **photo** of an entire onion plant. Ask:

    - Besides the onion, what other parts are visible in this picture?
    - How do the different parts of the onion work together to keep the plant alive and healthy?

        - Show pictures of a **shoot system** (one of the organ systems within a plant). Ask scholars to identify evidence in the picture that proves that the shoot system is an organ system. Then ask if they can think of the names of any of the organ systems in the human body.
        - Explain that organs are not always next to each other inside the body, even if they are in the same organ system. Organs are connected by their function, not their location.

- Ask: Do all living things contain entire organs/organ systems? How do you know?

    - Watch the **Levels of Organization video** (2 minutes, 29 seconds).
    - How might lacking organs or organ systems affect the abilities of unicellular/less complex organisms?
    - How can a person who begins as a single fertilized egg end up growing into a complex organism with several organ systems?

        - Explain that cells divide for growth, repair, and reproduction. Keep this pretty surface-level (do not delve into the details of cell division/mitosis and meiosis), as scholars will explore these during an upcoming unit.
            - Show part of the **From Zygote to Blastocyst** video (3 minutes, 36 seconds) as an example.
            - Ask scholars where they think cells come from, based on the video above.
            - Explain that all cells come from preexisting cells.
    - Ask: If all the parts of an onion plant are made from plant cells, why do they look so different?
        - Explore the **Cell Specialization and Differentiation** website on a viewable screen to help the class discover the answer. Then ask:
            - How are **specialized cells** different from one another? Why are they different?
        - Scholars revisit the chart from the beginning of the lesson and provide evidence to support or refute each idea.

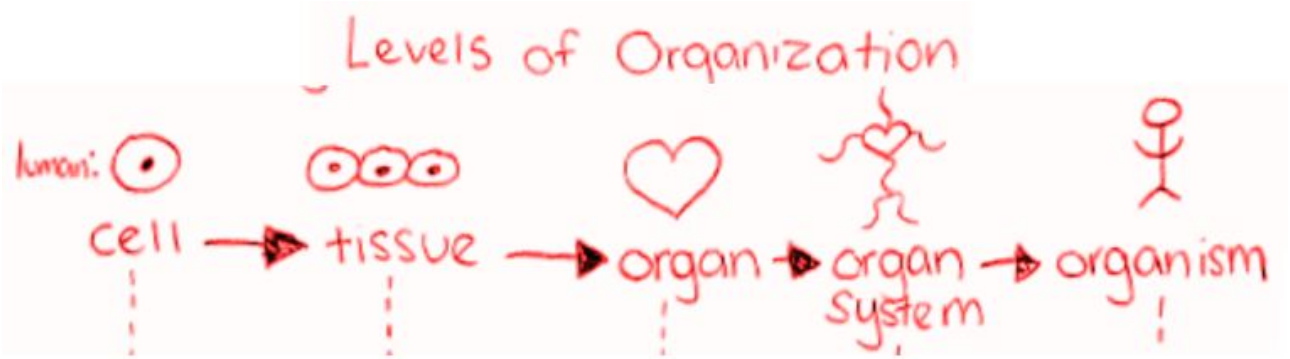
Make connections to the Essential Question:

- Ask: After today's lesson, how has your answer to the unit's Essential Question changed?

Accountability (Exit Ticket)

1. In the space below, draw a model that shows how cells organize into larger structures within our bodies. Include all levels of organization from cell to organism and add labels that explain your model. [3]

Exemplar:



Scoring Award points as follows:

1. Award one point for each of the following:
    - Work is clear and neat, and all required components are present (including a key if necessary)
    - All components are correctly ordered from least complex to most complex (up to two points; allow partial credit if two components are interchanged or out of place)

Lesson 7: The Cell Membrane

Lesson Objective: The cell membrane is a critical organelle for the health of every cell. Scholars can explain the job this organelle performs and the importance of selective permeability.
Materials Needed

- For each group: safety goggles, gloves, lab aprons, white paper, 2 sandwich bags, 2 plastic cups, 2 rubber bands, 2 plastic teaspoons, 2 pipettes, 2 stir sticks, 1 beaker of 300 mL of water, ¼ cup of cornstarch, and 10 mL of Lugol's solution

Prep

- Materials Prep:
    - Prepare the necessary materials for each group to conduct the experiment.
- Intellectual Prep:
    - Read the **Selectively Permeable Membranes: Definitions & Examples** article.

What are scholars doing in this lesson?

- Scholars conduct a lab using a provided procedure to model the function of an important organelle: the cell membrane.

Do Now

- Follow the **Do Now plan**.

Launch

- How do you think cells take in necessary materials, remove waste, and keep unwanted materials out?
- Introduce today's lab:
    - You will construct a model to learn the function of the cell membrane. The cell membrane plays a critical role in cellular health.

Experiment

- Scholars work in groups of four to prepare the experimental cups:
    - Scholars label the plastic cups "Cup 1" and "Cup 2."
    - Scholars pour 100 mL of water into each cup.
    - Scholars add 7 drops of Lugol's solution to Cup 1.
    - Scholars mix 1 teaspoon of cornstarch into Cup 2.

- Scholars split into pairs to prepare the experimental bags:
    - Pair 1 add 30 mL of water and a few drops of Lugol's solution to one sandwich bag.
    - Pair 2 mix 30 mL of water and a teaspoon of cornstarch into the other sandwich bag.
    - Pair 1 place their bag in "Cup 2."
    - Pair 2 place their bag in "Cup 1."
    - Scholars record their observations in their Lab Notebooks.
- While waiting for their test results, scholars create a data table.
- After recording their data, scholars answer an analysis question in their Lab Notebooks.
- Scholars review their results as a class:
    - Display a class data table and work with scholars to fill in the results.
- As scholars are working, circulate and press them to draw connections between the science content and the model.

Discourse Debrief experiment:

- Which part of your model represents the cell membrane? What about the cytoplasm?
- Were the starch and Lugol's solution able to pass through the cell membrane? Why or why not?
    - What do you think determines what can or cannot enter a real cell?
- Why is it important for the cell membrane to regulate which particles can pass through? What might happen if a cell membrane fails at this task?
- Explain:
    - The dissolved Lugol's particles were able to pass through the sandwich bag, while the larger starch particles could not. This is because the sandwich bag is **selectively permeable**, just like the cell membrane.
    - Selective permeability means that certain materials can cross the cell membrane, while others are kept out. This ensures that the cell receives vital materials (glucose, water, etc.) while being protected from harmful materials. It also allows for the disposal of waste.
    - Unlike the sandwich bags, cell membranes can change their **permeability** to serve the needs of the cell.
- Use the **Diffusion Across a Semipermeable Membrane** interactive simulation on a viewable screen.
    - Ask scholars to explain why the blue dots can cross the membrane but not the green ones.
    - Have scholars come up to adjust the pore size and then predict how that will change which dots can travel across the membrane.

Make broader connections:

- What might happen if the cell membrane failed to do its job?
    - On a large scale, how might this affect an organism?

Accountability (Exit Ticket)

1. Explain how the model created in today's lab demonstrated the function of a cell membrane. [2]

The cell membrane decides what goes in and out of the cell. The membrane allows vital materials inside the cell but prevents harmful ones from entering and damaging the cell. This is what happened in our experiment today: One material (Lugol's solution) was able to pass through the plastic bag but the other wasn't.

Scoring Award points as follows:

1. Award one point for each of the following:
    - An accurate response (should identify one specific feature of the model that demonstrated the function of a cell membrane)
    - An explanation to support the claim (should further explain the parallel between the model and a real cell membrane)

Lesson 8: The Cell as a City (Two Days)

Lesson Objective: Scholars synthesize their understandings from throughout the unit to complete their classwork. Strong work reflects mastery of the concepts of cellular composition and organization from all three Big Ideas. Materials Needed

- For the teacher: the **Plant and Animal Cell Organelles Key**
- For each group: colored pencils
- For each scholar: access to **What Are Cells video** from FuseSchool

Prep

- Intellectual Prep:
    - Read the **Plant and Animal Cell Organelles Key** to review organelle functions.

What are scholars doing in this lesson?

- Scholars create models to explain how the parts of a city are analogous to cell organelles.

Day One

Do Now

- Follow the **Do Now plan**.

Launch

- Share an example of an **analogy** with scholars.
- Ask scholars to explain the analogy and how an analogy works.
- Introduce today's activity: You will create a chart that uses analogies to compare the structures of a cell to the parts of a city. This chart will serve as your draft for a presentation you will make in the next lesson.

Activity

- Scholars watch the **What Are Cells video** either independently or as a class.
- Display the table below to showcase an example analogy of a cell as a car:
    - Discuss as a class how each cell structure represents the part of the car it's paired with.

Part of the Cell	Part of a Car
Cell membrane	The car door or the window
Cytoplasm	Air inside the car
Nucleus	The car driver
Nuclear membrane	The driver's seatbelt
Mitochondria	The engine or gasoline

- Explain that today groups will choose either a plant or animal cell and create a similar analogy and model comparing a cell to a city!
- As scholars are working, circulate and ensure they are all actively contributing. Press them to explain the parts of their model using specific evidence about the structure and function of each organelle they include.

Discourse Debrief activity:

- Share one or two incomplete models to share with the class. Have scholars show and explain their work. Ask:
    - What are the strengths of this work?
        - How clear is the work to you as a viewer? Why?
    - How could this work be improved?

Make broader connections:

- Ask: Why are models so important for scientists?
- Ask: What could you use this model for once it is complete?

Accountability (Informal)

- Listen closely as scholars share during the Discourse. Take note of any lingering misconceptions, and make a plan to follow up as needed on day two.

Day Two

Do Now

- Follow the **Do Now plan**.

Launch

- Share an example of scholar work that is in progress.
    - Ask the class to evaluate the work sample, providing both praise and constructive criticism. Review the work against the provided constraints.
- Remind scholars of their goal by the end of the class period.

Activity

- Scholars continue working on their “Cell as a City” models.
- As scholars are working, circulate and ensure they are all actively contributing. Press them to explain the parts of their model using specific evidence about the structure and function of each organelle they include.

Discourse Debrief activity:

- Choose exemplary models (one based on a plant cell and one based on an animal cell) to share with the class. Have scholars show and explain their work. Ask:
    - What makes this model strong?
    - Why do scientists create models?
        - How would this model help someone who has never heard of a cell before understand it?
    - How do these analogies help us understand the functions of cell structures and how they interact?
    - Is there any part of the cell city that is more important than the others? Explain.
    - How are the plant cell models different from the animal cell models? Why?

Make connections to the Essential Question:

- Ask: How does understanding the functions of cell structures help us answer the unit's Essential Question?

Make broader connections:

- Watch **How the Skin Heals Itself video** (3 minutes, 24 seconds) to wrap up the mystery posed at the beginning of the unit.

Accountability (Lab Notebook)

- Score scholar models in Lab Notebooks.

Scoring Award points as follows:

- Award one point for each of the following:
    - Each reasonable analogy between an organelle and a part of a city (up to four points in total)
    - Each correctly drawn and labeled analogous structure (up to four points in total)
    - A descriptive title

Lesson 9: Cell Poetry (Two Days)

Lesson Objective: Scholars synthesize their understandings from throughout the unit to complete their classwork. Strong work reflects mastery of the concepts of cellular composition and organization from all three Big Ideas. Materials Needed

- For the teacher: exemplar cell poem, sample poems

Prep

- Materials Prep:
    - Prepare an exemplar poem about an organelle to use as a model in class.

What are scholars doing in this lesson?

- Scholars craft their own poems that demonstrate understanding of cell structures and their functions.

Day One

Do Now

- Follow the **Do Now plan**.

Launch

- Share a few different poems with scholars that describe objects or organisms from **Poetry Soup**.
- Show scholars your exemplar cell poem and explain that they will be creating their own cell poetry!
    - Allow scholars to choose between focusing on one organelle or describing cells more broadly. (Those who select the latter must include descriptions of at least three organelles in their poems.)

Activity

- Scholars plan and then write their own poems that describe cell organelles and their functions.
- Scholars should consider the following guidelines when creating their poems:
    - Consideration of poem style (free verse, acrostic, haiku, I am, narrative, rhyming couplets, etc.)
    - A description of the physical characteristics of the cell, its organelles, and what makes them unique
    - A description of the job or function of the cell organelles
    - Personification, metaphors, or similes of the cell organelles
    - Giving the cell organelles a voice and character traits
    - Clear communication of imagery, tone, and symbolism
    - Consideration of rhyme, alliteration, assonance, hyperbole, onomatopoeia, and repetition

[**Tip:** Pair scholars who finish complete drafts early for peer review.]

Discourse Debrief activity:

- Share one to two poems in draft form (preferably from scholars who received peer feedback).
    - Ask the writer to share the feedback they got from their peer reviewer and explain how they implemented/intend to implement it.
    - After each reading, press scholars to identify the descriptive portions of their peers' poems that communicate scientific information about cell organelles.

Make connections to the Essential Question:

- Connect scholars back to the broader unit goals and Essential Question. Ask: How does everything we learned throughout this unit help us to answer the unit's Essential Question more robustly?

Accountability (Informal)

- Informally assess scholars as they work. Listen for lingering misconceptions and make a plan to follow up before the unit concludes.

Day Two

Do Now

- Follow the **Do Now plan**.

Launch

- Display one sample poem in progress. Ask scholars to evaluate the poem, pointing out both strengths and areas of weakness.
    - Remind scholars of the challenge: to write a poem about one cell organelle and its function(s).

Activity

- Scholars spend 20 minutes finishing their own poems.
    - Consideration of poem style (free verse, acrostic, haiku, I am, narrative, rhyming couplets, etc.)
    - A description of the physical characteristics of the cell, its organelles, and what makes them unique
    - A description of the job or function of the cell organelles
    - Personification, metaphors, or similes of the cell organelles
    - Giving the cell organelles a voice and character traits
    - Clear communication of imagery, tone, and symbolism

        - Consideration of rhyme, alliteration, assonance, hyperbole, onomatopoeia, and repetition

Discourse Debrief Activity

- Scholars present their poems. When applicable, the class tries to guess the subject of the poem.
    - After each reading, press scholars to identify the descriptive portions of their peers' poems that communicate scientific information about cell organelles.

Accountability (Exit Ticket)

1. Answer the unit's Essential Question: What are living things made of? Include at least three pieces of evidence from the unit to support your response. [4]

Living things (like us!) are made of cells. Cells are the smallest structural units of life, and every organism, living or dead, is made of them. The tiniest organisms on Earth are made from just one cell, while multicellular organisms can be composed of trillions.

Cells contain small parts called organelles that help them perform their functions. They can repair damage to our bodies, and they can reproduce to create new cells to help us grow. Cells in different parts of the body also specialize to do specific jobs within our bodies, which is why a skin cell, for example, might look different from a blood cell.

We aren't just a disorganized pile of cells, either. Cells become adjoined to neighboring cells to form tissue. That tissue forms organs (such as the heart, skin, or liver, for example). Organs connect within organ systems to carry out bigger functions for our bodies (such as digestion).

The human body is complex and fascinating. It is amazing to consider that everything from our eyes to our toes is composed of these impossibly tiny building blocks. Cells are the very foundation of all life, and without them, we would be no more alive than a rock or a drop of water.

Scoring: Award points as follows:

1. Award one point for each of the following:
    - A response that answers the Essential Question
    - Compelling evidence to support the response (up to three points in total)

[**Tip:** If you are unsure what constitutes an age-appropriate extended response, check with the Humanities teachers on your team!]

Unit Vocabulary

Vocabulary List

- **microscope**
- **cell**
- **unicellular**

- **multicellular**
- **organelle**
- **nucleus**
- **cytoplasm**
- **mitochondria**
- **chloroplast**
- **cell wall**
- **cell membrane**
- **vacuole**
- **system**
- **tissue**
- **organ**
- **organ system**
- **organism**
- **complex**
- **permeability**
- **selective permeability**
- **specialization/specialized cells**
- **analogy**