Engaging Students in 3-Dimensional Science Investigations using a Gather, Reason, Communicate (GRC) Lesson-MS
Welcome!

- Name
- Current Position
- County
- How did you hear about this PD?
# Webinar Resource Dashboard

## Engaging Students in Science Investigations Using Gather, Reason, Communicate (GRC)- Middle School Webinar Dashboard

**Facilitator:** Rebecca Garelli | Rebecca.Garelli@azed.gov

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<th>ADE Science Resource Page</th>
<th>ADE Science &amp; STEM Webinars</th>
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<td><img src="#" alt="Gray means we will open and use" /></td>
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<td>2</td>
<td><strong>3 Categories of Science &amp; Engineering Practices</strong></td>
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<td>3</td>
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</tr>
</tbody>
</table>

- Presentation PDF: [PDF of Slides](#)
- Books: Investigating Using GRC and Teaching Science is Phenomenal
- 5 Different Species of Leaves Images & Video
- Assessing Practices Along a Continuum Article from NSTA
- The Wonder of Science 3-D Cards
- #Going 3D w/GRC Main Website
- K-12 Planning Summaries
- 6-8 Grade GRC Lesson Used in this Webinar- Green Leaves
- 6-8 GRC Lesson with Language Acquisition Strategies - Green Leaves

**MAKE A FORCED COPY**

To: Everyone

done
• Become familiar with and experience a lesson that utilizes the Gather, Reason, Communicate (GRC) approach to sensemaking

• Explore a few digital strategies to help students to gather evidence to construct and revise explanations.

• Deepen understanding of the 3-dimensional approach to science teaching and learning & how this approach connects to the AzSS
Dear Teacher of Science,

Thank you for continuing to support your students during the Covid-19 Pandemic. Below is a link to ideas on ways to engage your students as they learn from home through your thoughtful guidance.

Investigations Beyond the Classroom

Going 3D with GRC Lesson Website and Resources

#Going 3D w/GRC Main Website

6-8 Grade GRC Lesson Used in this Webinar - Green Leaves

6-8 GRC Lesson with Language Acquisition Strategies - Green Leaves
## Arizona Science Standards in Lesson

**Lessons on this website are connected to NGSS**

<table>
<thead>
<tr>
<th><strong>MS-LS1-2</strong> Cell structure and function</th>
<th><strong>Green Leaves</strong></th>
<th><strong>Structure and Function of Cells Photosynthesis</strong></th>
<th><strong>Phenomenon: Leaves are darker on the top as compared to the underside.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HI OR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th><strong>Green Leaves Language Acquisition</strong></th>
<th><strong>Hilo Hi</strong></th>
<th><strong>Structure and Function of Cells Photosynthesis</strong></th>
<th><strong>Phenomenon: Leaves are darker on the top as compared to the underside.</strong></th>
<th><strong>GRC Engage Explore</strong></th>
<th>The lesson is the same as the above lesson but includes Language</th>
</tr>
</thead>
</table>

### Main Connected Arizona Science Standard

Life Science: Students develop an understanding of the structure and function of cells.

<table>
<thead>
<tr>
<th>Arizona Science Standards- 7th Grade Life</th>
<th>Next Generation Science Standards- 7th Grade Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.L1U1.8 Obtain, evaluate, and communicate information to provide evidence that all living things are made of cells, cells come from existing cells, and cells are the basic structural and functional unit of all living things.</td>
<td>P MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.</td>
</tr>
<tr>
<td>7.L1U1.9 Construct an explanation to demonstrate the relationship between major cell structures and cell functions (plant and animal).</td>
<td>P MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.</td>
</tr>
</tbody>
</table>
Bundled Standards for One Lesson

3D-Student Science Performance
Authors: Lance Nishimura, Hawaii, Jackie Sampsell, North Carolina, and Jamie Rumage, Oregon

Grade: 6-8
Lesson Title: Green Leaves

Lesson Topic: Structure and Function of Plant Cells

Performance Expectations (Standard) from State Standards or NGSS:

**MS-LS1-2.** Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function. [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.]

**MS-LS1-6.** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and the flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing the movement of matter and the flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]

7.L2U1.12 Construct an explanation for how some plant cells convert light energy into food energy.

7.L1U1.9 Construct an explanation to demonstrate the relationship between major cell structures and cell functions (plant and animal).
Planning Summaries to Compare the AzSS to NGSS

<table>
<thead>
<tr>
<th>Life Science: Students develop an understanding of the structure and function of cells.</th>
<th></th>
</tr>
</thead>
<tbody>
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<td><strong>Arizona Science Standards- 7th Grade Life</strong></td>
<td><strong>Next Generation Science Standards- 7th Grade Life</strong></td>
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<td>7.L1U1.8 Obtain, evaluate, and communicate information to provide evidence that all living things are made of cells, cells come from existing cells, and cells are the basic structural and functional unit of all living things.</td>
<td>P</td>
</tr>
<tr>
<td>7.L1U1.9 Construct an explanation to demonstrate the relationship between major cell structures and cell functions (plant and animal).</td>
<td>P</td>
</tr>
<tr>
<td>7.L1U1.10 Develop and use a model to explain how cells, tissues, and organ systems maintain life (animals).</td>
<td>NC</td>
</tr>
<tr>
<td>7.L1U1.11 Construct an explanation for how organisms maintain internal stability and evaluate the effect of the external factors on organisms’ internal stability.</td>
<td>NC</td>
</tr>
<tr>
<td>7.L2U1.12 Construct an explanation for how some plant cells convert light energy into food energy.</td>
<td>P</td>
</tr>
</tbody>
</table>

**Alignment of the AzSS to NGSS Performance Expectations**

Note: An “S” or “P” alignment indicates that an NGSS resources could be used. An “NC” indicates that an NGSS resources cannot be used.

- **S** = Strong: Both the Core Idea and Science and Engineering Practice (SEP*) are the same
- **P** = Partial: Core idea is closely related; SEP may or may not match
- **NC** = Not Closely Correlated: There is no strong or partial correlation in this grade band
3-Dimensions in Bundled Standards

**Science & Engineering Practice(s)**

- Constructing Explanations
- Asking Questions
- Obtaining, Evaluating, and Communicating Information
- Developing and Using Models
- Engaging in Argument from Evidence

**Crosscutting Concepts**

- Patterns
- Systems
- System Models
- Structure Function

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**Core Ideas for Knowing Science**

**Physical Science**
- P1: All matter in the Universe is made of very small particles.
- P2: Objects can affect other objects at a distance.
- P3: Changing the movement of an object requires a net force to be acting on it.
- P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.

**Earth and Space Science**
- E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth’s surface and its climate.
- E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.

**Life Science**
- L1: Organisms are organized on a cellular basis and have a finite life span.
- L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.
- L3: Genetic information is passed down from one generation of organisms to another.
- L4: The unity and diversity of organisms, living and extinct, is the result of evolution.

**Core Ideas for Using Science**

- U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.
- U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.
- U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.

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**Construct an explanation** to demonstrate the relationship between major cell structures and cell functions (plant and animal).

**Construct an explanation** for how some plant cells convert light energy into food energy.
# Arizona Science Standards in Lesson

## Life Sciences: Students develop an understanding of the structure and function of cells.

<table>
<thead>
<tr>
<th>Life Science Standards</th>
<th>Crosscutting Concepts and Background Information for Educators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7.L1U1.8</strong></td>
<td><strong>Crosscutting Concepts:</strong> Patterns; Cause and Effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; <strong>Structure and Function</strong>; Stability and Change.</td>
</tr>
</tbody>
</table>
| **Obtain, evaluate, and communicate information** to provide evidence that all living things are made of cells, cells come from existing cells, and cells are the basic structural and functional unit of all living things. | **Background Information:** All living organisms are made of one or more cells, which can be seen only through a microscope. All the basic processes of life are the results of what happens inside cells. Cells divide to replace aging cells and to make more cells in growth and reproduction. Food is the energy source they need in order to carry out these and other functions. 

2. Life is the quality that distinguishes living things - composed of living cells, from nonliving objects or those that have died. While a simple definition of life can be difficult to capture, all living things - that is, all organisms - can be characterized by common aspects of their structure and function. Some cells in **multicellular organisms**, as well as carrying out the functions that all cells do, are specialized, for example, muscle, blood and nerve cells carry out specific functions within the organism. Cells are often aggregated into tissues, tissues into organs, and organs into **organ systems**. In the human body, systems carry out such key functions as respiration, digestion, elimination of waste and temperature control. The circulatory system takes material needed by cells to all parts of the body and removes soluble waste to the urinary system. Stem cells, which are not specialized, are capable of repairing tissues by being programmed for different functions. Cells function best in certain conditions. Both single cell and multi-cellular organisms have mechanisms to maintain temperature and acidity within certain limits that enable the organism to survive. Organisms are complex, organized and built on a hierarchical foundation of elements and atoms, to cells and systems of individual organisms to... |
| **7.L1U1.9**           | **Construct an explanation** to demonstrate the relationship between major cell structures and cell functions (plant and animal). |
| **Develop and use a model** to explain how cells, tissues, and organ systems maintain life (animals). |
Science Performances – Students making sense of phenomena

Teaching Science is Phenomenal
Using Phenomena to Engage Students in Three-Dimensional Science Performances Consistent with the NRC Framework and NGSS

Organizing Student Science Performances Using SE and Gather, Reason, Communicate Instructional Sequences
Brett D. Moulding & Rodger W. Bybee

Engaging Students in Science Investigation Using GRC
Science Instruction Consistent with the NRC Framework and NGSS
Brett Moulding
Kenneth Huff
Wil van der Veen

Adapted from PD with Brett Molding with ADE & SRP, November 2019
GRC Approach

Gather
- Obtain Information
- Ask Questions/Define Problems
- Plan & Carry Out Investigations
- Use Mathematics & Computational Thinking to Gather and Organize Information
- Use Models to Organize Data and/or Information

Reason
- Evaluate Information
- Analyze Data
- Use Mathematics and Computational Thinking to Determine Relationships
- Construct Explanations/Solve Problems
- Develop Arguments for how the Evidence Supports an Explanations
- Use Models to Predict & Develop Evidence

Communicate Reasoning
- Communicate Information and data
- Communicate Arguments (written/oral) for how the Evidence Supports an Explanation
- Use Models to Communicate Reasoning

(Moulding, 2012)
GRC Approach

Phenomena-Based Teaching & Learning

**Engage** students in observing phenomena and provide students the opportunity to develop meaningful questions to investigate the causes of the phenomena.

Students will **gather** information and data which they will use to support their explanations. Students will also **reason** to analyze data to use as evidence and **communicate** their findings.

**Motivate** students to **apply** their knowledge of science to make sense of other phenomena, outside of the classroom.
#Going3D w/GRC 7th Grade Lesson

**Phenomenon:** Leaves are darker on the top than the underside.

**Group Performances:**
1. *Explore* leaves by going outside to collect two leaves from 3-5 different plants.
2. *Observe* leaves carefully and look for *patterns* across all of the leaves.

**Class Discussion about Patterns**

**Continue Group Performances:**
3. *Develop questions* to obtain information about the *patterns* they observe of leaves being a different shade of green on the top than on the bottom.

**Class Discussion about good Questions**

**Continue Group Performances:**
4. *Obtain information* from reliable sources to use as evidence for how the *structure* of the leaf *functions* to meet the needs of the plant.
5. *Construct explanations* for how the *structure* of the darker top and light underside of leaves *functions* in leaves.
6. *Develop a model* to show differences in the *structure* of cells on the top and bottom of a leaf.

**Class Discussion**

7. *Revise and use your model* to support an *explanation* for how a cell as a whole and ways the parts of the cell contribute to the *function*.

**Individual Performances:** (SSW)
8. *Develop an argument* for how the evidence you have gathered supports the *explanation* that the *structure* of the leaf *functions* to meet the needs of the plant. (SSW)
Gather

Group Performance- in Pairs (if w/students)

- **Explore** leaves by going outside to collect two leaves from 3-5 different plants. The leaves may be from trees, bushes, weeds, and/or flowers.

- **Observe** leaves carefully and look for *patterns* across all of the different species of leaves. **Write a list of observed patterns** in a S-T-W table.
Leaves from 5 Different Species

Gather

Observe leaves carefully and look for patterns across all of the different species of leaves. Write a list of observed patterns in a S-T-W table.

Topside

 Underside
**See-Think-Wonder**

**Green Leaves**

**Alone Zone (2 minutes)**

Carefully **observe** the leaves and look for **patterns**. Complete the see-think-wonder chart below. You should record observations ("I see..."), ideas you have about what is going on ("I think..."), and questions that you would like to investigate ("I wonder...").

<table>
<thead>
<tr>
<th>SEE</th>
<th>THINK</th>
<th>WONDER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What do you see?</strong></td>
<td><strong>What do you think is going on?</strong></td>
<td><strong>What does it make you wonder?</strong></td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td></td>
</tr>
</tbody>
</table>

6
Small Group

**MOVE 1: Share observations with your group:**
- Review your observations
- Choose **two** observations to post
- Post your observations on Jamboard (one observation per sticky note) Please post on BLUE

**Move 2: When posting slows:**
- **Circle** at least one observation someone in your group noticed that you did not (multiple people can circle the same observation)
- **Put a check mark** next to at least one observation someone noticed that you also noticed.
- Post **patterns** your group identifies **GREEN**
Class Discussion About Patterns & Predictions

Whole Group Noticings/Patterns: (I will take notes)

Based on the observed pattern(s), what are your predictions?

•
Asking Questions

Continued Group Performance (3 minutes Alone Zone)

Phenomenon - Leaves are green, however the top side of a leaf is a different shade of green than the bottom side of the leaf.

• Develop questions to obtain information about the patterns you observe of leaves being a different shade of green on the top than on the bottom.
Before typing in chat box:

- Review your own observations and the observations of your group.
- Review and/or add to the questions you recorded in “I wonder” column of your table.
- Choose one question to share that answering may help us make sense of the phenomenon.

Type in chat box, but DO NOT HIT ENTER!

(wait for countdown- 3,2,1..waterfall!)
Investigation: Green Leaves

Phenomenon: Leaves are darker on the top than the underside.

Group Performances:
1. Explore leaves by going outside to collect two leaves from 3-5 different plants.
2. Observe leaves carefully and look for patterns across all of the leaves.

Class Discussion about Patterns

Continue Group Performances:
3. Develop questions to obtain information about the patterns they observe of leaves being a different shade of green on the top than on the bottom.

Class Discussion about good Questions

Continue Group Performances:
4. Obtain information from reliable sources to use as evidence for how the structure of the leaf functions to meet the needs of the plant.
5. Construct explanations for how the structure of the darker top and light underside of leaves functions in leaves.
6. Develop a model to show differences in the structure of cells on the top and bottom of a leaf.

Class Discussion

7. Revise and use your model to support an explanation for how a cell as a whole and ways the parts of the cell contribute to the function.

Individual Performances: (SSW)
8. Develop an argument for how the evidence you have gathered supports the explanation that the structure of the leaf functions to meet the needs of the plant. (SSW)
Gather

Obtain information from reliable sources for how the structure of a leaf functions to meet the needs of the plant.

Appendix B - 1 Reading

What Makes Plants Green?

The green color in plants is caused by the presence of chloroplasts inside plant cells. Chloroplasts contain chlorophyll, the molecule that captures energy from the sun to rearrange carbon dioxide and water into sugar. This process that happens in the chloroplast is called photosynthesis. The green color of chlorophyll is why plants are mostly green.

Chlorophyll is one of several pigments in plants that absorb light energy. Each type of plant reveals the color of the pigmentation that best allows them to absorb sunlight based on light conditions in the environment where they live. Some environments are bright, some are darker, but all provide some light or the plant could not live. The amount of sunlight in the desert is greater than the amount of light in a dark forest, so the shade of green for plants from these two environments are different.

During autumn, plants and leaves in some locations change color to red, orange, and/or yellow. This process is due to the plant receiving less sunlight each day. When plants receive less sunlight it triggers a process in the plant that reduces the amount of chlorophyll in the cells of the leaves and changes the chlorophyll so it can be stored for the winter. The decrease in sunlight causes the plants to take apart the chlorophyll and store the parts of the molecules. When this happens other natural pigmentation in the plants can be seen because they are not hidden by the green color of the chlorophyll.
**Investigation: Green Leaves**

**Phenomenon:** Leaves are darker on the top than the underside.

**Group Performances:**
1. **Explore** leaves by going outside to collect two leaves from 3-5 different plants.
2. **Observe** leaves carefully and look for patterns across all of the leaves.

**Class Discussion about Patterns**

**Continue Group Performances:**
3. **Develop questions** to obtain information about the patterns they observe of leaves being a different shade of green on the top than on the bottom.

**Class Discussion about good Questions**

**Continue Group Performances:**
4. **Obtain information** from reliable sources to use as evidence for how the structure of the leaf structure functions to meet the needs of the plant.
5. **Construct explanations** for how the structure of the darker top and light underside of leaves functions in leaves.
6. **Develop a model** to show differences in the structure of cells on the top and bottom of a leaf.

**Class Discussion**

7. **Revise and use your model** to support an explanation for how a cell as a whole and ways the parts of the cell contribute to the function.

**Individual Performances:** (SSW)
8. **Develop an argument** for how the evidence you have gathered supports the explanation that the structure of the leaf functions to meet the needs of the plant. (SSW)
Constructing Explanations - Group Performance

**Reason**

*Construct explanations* for how the *structure* of the darker top and light underside of leaves *functions* in leaves.

*Develop a model* to show differences in the *structure* of cells on the top and bottom of a leaf.

---

**Make a Group:**

Please enter your name in the first available cell, filling the table from left to right and then top to bottom. Click on your group number, then click on Bookmark to quickly navigate to your group's table.

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Group 6</th>
</tr>
</thead>
</table>

Click on your group number to quickly find your table Group 1 Group 2 Group 3 Group 4 Group 5 Group 6

**Alone Zone**

*Develop a model* to show differences in the *structure* of cells on the top and bottom of a leaf.

*Construct an explanation* supported by evidence for how the leaf *structure* (darker green on top) is consistent with the *function* of the leaf as part of the plant *system*.

**Small Group**

- Identify at least one similarity and one difference between your model and another group member’s.
"Breakout" Rooms - Share & Discuss Models

Group 1
Name: Rebecca - EXAMPLE

Model:

![Leaf Diagram](image)

Key: □ less chlorophyll □ more chlorophyll

Explanation: On the underside of the leaf there are tightly packed palisade cells that have more
Questions to initiate Discussion:

Q: What structure in plant cells causes the green coloration of the leaf?
Q: How does the structure of the top side of a leaf differ from the bottom side?
Q: Why is the function of the top of a leaf different from the function of the underside of a leaf?
Q: What is the role of the leaves in the plant system?
Q: Why is energy input important to cells of the leaf?
Q: Where does the matter come from for the process of photosynthesis?
Investigation: Green Leaves

Phenomenon: Leaves are darker on the top than the underside.

Group Performances:
1. Explore leaves by going outside to collect two leaves from 3-5 different plants.
2. Observe leaves carefully and look for patterns across all of the leaves.

Class Discussion about Patterns

Continue Group Performances:
3. Develop questions to obtain information about the patterns they observe of leaves being a different shade of green on the top than on the bottom.

Class Discussion about good Questions

Continue Group Performances:
4. Obtain information from reliable sources to use as evidence for how the structure of the leaf functions to meet the needs of the plant.

5. Construct explanations for how the structure of the darker top and light underside of leaves functions in leaves.

6. Develop a model to show differences in the structure of cells on the top and bottom of a leaf.

Class Discussion

7. Revise and use your model to support an explanation for how a cell as a whole and ways the parts of the cell contribute to the function.

Individual Performances: (SSW)
8. Develop an argument for how the evidence you have gathered supports the explanation that the structure of the leaf functions to meet the needs of the plant. (SSW)
Revisit Model & Explanation- Add to it!

**Group 1**

**Name:** Rebecca - EXAMPLE

**Model:**

- **Topside of Leaf**
  - **Underside of Leaf**
  - **Key:** 
    - less chlorophyll
    - more chlorophyll

**Explanation:** On the underside of the leaf there are tightly packed palisade cells that have more
Investigation: Green Leaves

Phenomenon: Leaves are darker on the top than the underside.

**Group Performances:**
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**Continue Group Performances:**
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**Class Discussion**

7. *Revise and use your model* to support an *explanation* for how a cell as a whole and ways the parts of the cell contribute to the *function*.

**Individual Performances: (SSW)**
8. *Develop an argument* for how the evidence you have gathered supports the *explanation* that the *structure* of the leaf *functions* to meet the needs of the plant. (SSW)
Evidence for Arguments

Communicate

**Individual Performances:** (SSW)

*Develop an argument* for how the evidence you have gathered supports the *explanation* that the *structure* of the leaf *functions* to meet the needs of the plant. (SSW)
Support for Individual Performance - Evidence Collector & Sentence Frames

Evidence Collector for Engaging in Argument from Evidence

1. Construct explanations for how the **structure** of the darker top and light underside of leaves **functions** in leaves.

<table>
<thead>
<tr>
<th>Evidence from Data in S-T-W Chart:</th>
<th>How does this evidence support the explanation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evidence from Reading:</th>
<th>How does this evidence support the explanation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evidence from Class Discussion:</th>
<th>How does this evidence support the explanation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td></td>
</tr>
</tbody>
</table>

2. Develop an argument for how the evidence you gathered in the investigation support/refute your group's **explanation structures** in leaves **function** to meet the needs of the plant **system**.

<table>
<thead>
<tr>
<th>Possible sentence starters for evidence:</th>
<th>Possible sentence starters for reasoning/support:</th>
</tr>
</thead>
<tbody>
<tr>
<td>One piece of evidence is _____________</td>
<td>This is important because ______________.</td>
</tr>
<tr>
<td>Another piece of evidence is __________</td>
<td>This shows that __________.</td>
</tr>
<tr>
<td>One observation/notice _______________</td>
<td>This proves that ______________.</td>
</tr>
<tr>
<td>The pattern our group noticed was _______</td>
<td>This supports the evidence because __________.</td>
</tr>
<tr>
<td>The reading states, _________________</td>
<td>This evidence suggests that __________, which means __________.</td>
</tr>
<tr>
<td>During the class discussion, our class figured out __________</td>
<td>The pattern our group noticed was __________, this means __________.</td>
</tr>
</tbody>
</table>

Sentence Frames:

- ___________ and ___________ function together to ___________.
- The ___________ supports cellular function by ___________.
- ___________ supports the production of energy in a cell by ___________.

Page 11
# Evidence of Learning - Formative Assessment

**Formative Assessment for Student Learning**

**Elicit Evidence of Learning** *Develop an argument* for how the evidence they have gathered supports the explanation that the *structure* of the leaf *functions* to meet the needs of the plant.

<table>
<thead>
<tr>
<th>Evidence of Student Proficiency</th>
<th>Range of Typical Student Responses</th>
<th>Acting on Evidence of Learning</th>
</tr>
</thead>
</table>
| Student models provide evidence of the relationship between the structure and function in a leaf system evidence for the transformation of energy in the process of photosynthesis inputs and outputs of matter in the leaf system causes for the difference in color between top and bottom of the leaf. | **Descriptors of grade-level-appropriate student responses:**  
  - **Full understanding** - The model shows a higher concentration of chloroplasts at the top of the leaf and connects concentration to the difference in color between top and bottom. The model represents the effect of sunlight on the process of photosynthesis. The model shows the rearrangement of matter (oxygen, sugar, carbon dioxide, and water).  
  - **Partial understanding** - The model shows a higher concentration of chloroplasts at the top of the leaf, but *does not make the connection* to the function of the chloroplasts or color difference between top and bottom. The model represents sunlight but *does not directly connect* to the process of photosynthesis. The model shows the rearrangement of some of the types of matter (oxygen, sugar, carbon dioxide, and water).  
  - **Limited understanding** - The model *does not include* the role of light inputs in the system. The model indicates that there is more photosynthesis or more chloroplasts at the bottom of the leaf. The model may include a formula but *does not show evidence* of a connection between the formula and processes involved in photosynthesis. | *Description of instruction action and response to support student learning.*  
  Engage in Simulations of photosynthesis and add understanding to their model:  
  - [https://learn.concord.org/resources/1101/photosynthesis](https://learn.concord.org/resources/1101/photosynthesis)  
  - [http://www.reading.ac.uk/virtualexperiments/ves/preloader-photosynthesis-full.html](http://www.reading.ac.uk/virtualexperiments/ves/preloader-photosynthesis-full.html)  
  - Extensions of learning for students who display a full understanding  
  - Gather information on leaf pigmentation [http://harvardforest.fas.harvard.edu/leaves/pigment](http://harvardforest.fas.harvard.edu/leaves/pigment) and make connections to change in full colors of leaves. |
Revisit the Phenomena

**Phenomenon:** Leaves are darker on the top than the underside.

**Group Performances:**
1. **Explore** leaves by going outside to collect two leaves from 3-5 different plants.
2. **Observe** leaves carefully and look for **patterns** across all of the leaves.

**Class Discussion about Patterns**

**Continue Group Performances:**
3. **Develop questions** to obtain information about the **patterns** they observe of leaves being a different shade of green on the top than on the bottom.

**Class Discussion about Good Questions**

**Continue Group Performances:**
4. **Obtain information** from reliable sources to use as evidence for how the **structure** of the leaf **functions** to meet the needs of the plant.
5. **Construct explanations** for how the **structure** of the darker top and light underside of leaves **functions** in leaves.
6. **Develop a model** to show differences in the **structure** of cells on the top and bottom of a leaf.

**Class Discussion**

7. **Revise and use your model** to support an **explanation** for how a cell as a whole and ways the parts of the cell contribute to the **function**.

**Individual Performances:** (SSW)
8. **Develop an argument** for how the evidence you have gathered supports the **explanation** that the **structure** of the leaf **functions** to meet the needs of the plant. (SSW)
Standards that Spiral- Leaves

Leaf Structure and Function – Turning Over a New Leaf

K.L1U1.6 Obtain, evaluate, and communicate information about how organisms use different body parts for survival.

2.L2U1.9 Obtain, analyze, and communicate evidence that organisms need a source of energy, air, water, and certain temperature conditions to survive.

3.L1U1.5 Develop and use models to explain that plants and animals (including humans) have internal and external structures that serve various functions that aid in growth, survival, behavior, and reproduction.

7-LS2U1.9 Construct an explanation to demonstrate the relationship between major cell structures and cell functions (plant and animal).

7-LS2U1.12 Construct an explanation for how some plant cells convert light energy into food energy.

8.L4U1.11 Develop and use a model to explain how natural selection may lead to increases and decreases of specific traits in populations over time.

HS.L2U1.21 Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.

Plus HS+B.L2U1.8 Develop and use models to develop a scientific explanation that illustrates how photosynthesis transforms light energy into stored chemical energy and how cellular respiration breaks down macromolecules for use in metabolic processes.
# Simplicity of Phenomena

<table>
<thead>
<tr>
<th>MS-LS1-2</th>
<th>Cell structure and function</th>
<th>The Root of the Matter</th>
<th>HI</th>
<th>Cell Parts &amp; Function</th>
<th>Phenomenon: Roots are not green.</th>
<th>GRC Explore Explain</th>
<th>The investigation provides insights into differences in how cells function. Includes formative assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS-LS1-2</td>
<td>Cell structure and function</td>
<td>Hairy Roots</td>
<td>This lesson still needs to be developed</td>
<td>Phenomenon: Plant roots are hairy looking. Some are more hairy looking than others.</td>
<td>GRC</td>
<td>A good lesson to start a unit on organelles</td>
<td>Includes formative assessment</td>
</tr>
<tr>
<td>MS-LS1-2</td>
<td>Cell structure and function</td>
<td>Where's My Nucleus</td>
<td>PA</td>
<td>Cells and Organelles Structure and Function</td>
<td>Phenomenon: Red blood cells do not have a nucleus.</td>
<td>GRC</td>
<td>This investigation has students using chicken feet to understand structure and function. Includes formative assessment</td>
</tr>
<tr>
<td>MS-LS1-3</td>
<td>Hierarchy of systems in organisms</td>
<td>Chicken Feet and Muscles</td>
<td>UT, OK</td>
<td>Hierarchy of cells, tissues, organs, and organs systems</td>
<td>Phenomenon: Chicken feet are made of chicken parts. Phenomenon: A Chicken foot does not have large muscles.</td>
<td>GRC</td>
<td>This investigation uses prepared slides of blood and tissue. Includes formative assessment</td>
</tr>
<tr>
<td>MS-LS1-3</td>
<td>Hierarchy of systems in organisms</td>
<td>My Pulse</td>
<td>AZ</td>
<td>Circulatory System</td>
<td>Phenomenon: I can feel my pulse in my neck after I exercise.</td>
<td>GRC</td>
<td>This lesson model and then engages students in developing reports about the effects of diseases on</td>
</tr>
</tbody>
</table>
Thank you for sharing this space!

What questions do you have?

Use a strategy called “stack”- helps build a virtual “line” or stack

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