Template for Integrating the NGSS and Common Core into Lesson Plans

I. Goals and Essential Questions:

- List and discuss the lesson's **Goals**.
- Provide **Focus Questions** (and/or where relevant **Essential Questions**).
- **NGSS Note:** This is about making students think, not just memorize, so ask as many questions as you can to get their minds stirring. Motivate them whereever possible to ask questions as well. Inquiry is not just about experiments and analyzing data. It is also about research, reading on topic, asking questions and finding the answer, watching compelling movies, developing models that help with understanding. ***Think, question, entertain ideas.***

II. Introductory Activities to Assess Prior Knowledge

Start with an introductory activity, word merge, or brainstorming session to **Assess Prior Knowledge**.

- **NGSS Note:** Comparing pre and post assessment is telling and can provide valuable information about how your students are progressing. Ask questions and motivate them to ask questions.

III. New Knowledge - Text

- Provide a **reading assignment** (or lecture and while they take notes) introducing your **New Content**.
- Assign a **Vocabulary Assessment** and **Reading Comprehension Assessment** of the new content in the form of a labeling page, short answer quiz or authentic performance activity (*provide a scenario that uses the content and ask related questions – this can be used as a "model" as well).
- **Introduce a Model** that depicts the concept expressed in the reading (students should begin to think about their own model building).
- Assign a **Vocabulary Assessment** and **Reading Comprehension Assessment** of the model.
- **NGSS Note:** Promote inquiry by having them take the core concept they gleaned from the reading, go online and find current research about it, a current events article about it, a video that explains it in a different way, a Gary Larson cartoon that uses the concept in parody -- anything that shows they understand the concept and can think about it beyond the classroom. Think, question, entertain ideas.

IV. Experiments, Activities, Model-making, Media (Critical Thinking)

- Follow with an **Alternate Media Experience** of the content via video, movie or podcast. Discuss.
- Assign a **Comprehension Assessment** of the movie content - this can be a vocabulary or concept quiz or an **Authentic Performance Activity** that gets them thinking about how this concept would be useful in the "real world."

- **Do Experiments, Activities, and Studies** where they will Predict-Observe-Explain (POE). Pay attention to the **8 Science and Engineering Practices** and **Common Core** you need to address with this.
- **NGSS Note:** Using "cook book" labs are appropriate if you tweak them a bit to introduce more critical thinking at each step. For instance, if the lab will involve the CO_2 indicated in a test tube by BTB (as in the sample lesson below), before they are instructed to blow into the test tube to introduce the CO_2, spend some time asking them to come up with how they can get CO_2 into the test tube. Make the connection that they are producing CO_2 every time they exhale. Again think, question, entertain ideas.
- When appropriate, have students undertake a **Model Development Activity** to represent the content (this can be a diagram, graph, dramatization, authentic performance, physical model, etc.).
- Pay attention to the **7 Crosscutting Concepts** you need to address Models.
- Assign a **Comprehension Assessment** of the Experiment, Activity or Model. This can be in the form of a labeling page, short answer quiz, authentic performance activity, skit, even the development of an ironic cartoon about the content.

V. **Summarize** their new knowledge and vocabulary. List their **Enduring Understandings**.

- **NGSS Note:** Have *them* list what they learned. Display the models they developed.

Vl. NGSS and Common Core Addressed:

- **NGSS Note:** List these before your lessons to start thinking about how to address the critical content for your students' age level (and comprehension level). This is a shift to more critical thinking. Its integration will grow over time.

Disciplinary Core Ideas (DCI) (Appendix E) that apply to your lesson.

Crosscutting Concepts (Appendix G) that apply to your lesson.

Science and Engineering Practices (Appendix F) that apply to your lesson.

Common Core Standards connections.

Finding the **NGSS and Common Core** for each of your lessons at the correct age level: LINK

http://www.nextgenscience.org/search-standards-dci

Photosynthesis Lesson (5-6 classroom sessions)

Developed by Judy Poticher (Gouverneur MS) through a grant provided by the Title ll – Part B Math/Science Partnership and in collaboration with Sheri Amsel and www.exploringnature.org

l. Goals and Essential Questions:

1) Understand the process of photosynthesis, what is going into it, and what is created by it.
2) Be able to describe the parts of the photosynthesis equation.
3) Understand how photosynthesis affects our world.

Essential Questions:

1) Why are plants essential to life on Earth?
2) How is sunlight (through photosynthesis) tied into every food web on Earth?
3) How is sunlight (through photosynthesis) tied to the living things on Earth having enough oxygen to breathe?

ll. Introductory Activities to Assess Prior Knowledge

Question: What does a plant need to stay alive (and perform photosynthesis)?

A. Brainstorm

1. Break students down into groups of 3-4.
2. Ask students to generate a list of what a plant needs to stay alive.
3. Discuss

lll. New Knowledge - Text (below)

Read about Photosynthesis and look at the **Photosynthesis Model**

- Vocabulary Assessment - Short Answer
- Reading Comprehension Assessment - Multiple Choice Quiz
- Photosynthesis Model Labeling Assessment

Authentic Performance - Life without the Sun (Below)

- Read the scenario.
- Using your new knowledge, answer the questions.

Other Media - Video

- Watch short video
- Complete short answer page.

lV. Experiments, Activities, Model-making, Media (Critical Thinking)

- **Introductory Experiment - Elements of Photosynthesis l** (instructions below)
  1. Predict - Observe - Explain
  2. Answer Assessment Questions integrated in the activity.

- **Experiment 2 - Elements of Photosynthesis 2** (instructions below)
  1. Predict - Observe - Explain
  2. Answer Assessment Questions integrated in the activity.

V. Summarize Knowledge - Enduring Understandings

1) Plants need sunlight, water and carbon dioxide to produce oxygen and energy (in the form of glucose).
2) The ability of plants to produce energy from the sun (water & CO_2) is the basis of all the food webs on Earth.
3) The ability of plants to produce oxygen from the sun (water, CO_2) is the basis of all O_2 breathing life on Earth.

Vl. NGSS and Common Core Integration

Photosynthesis Reading

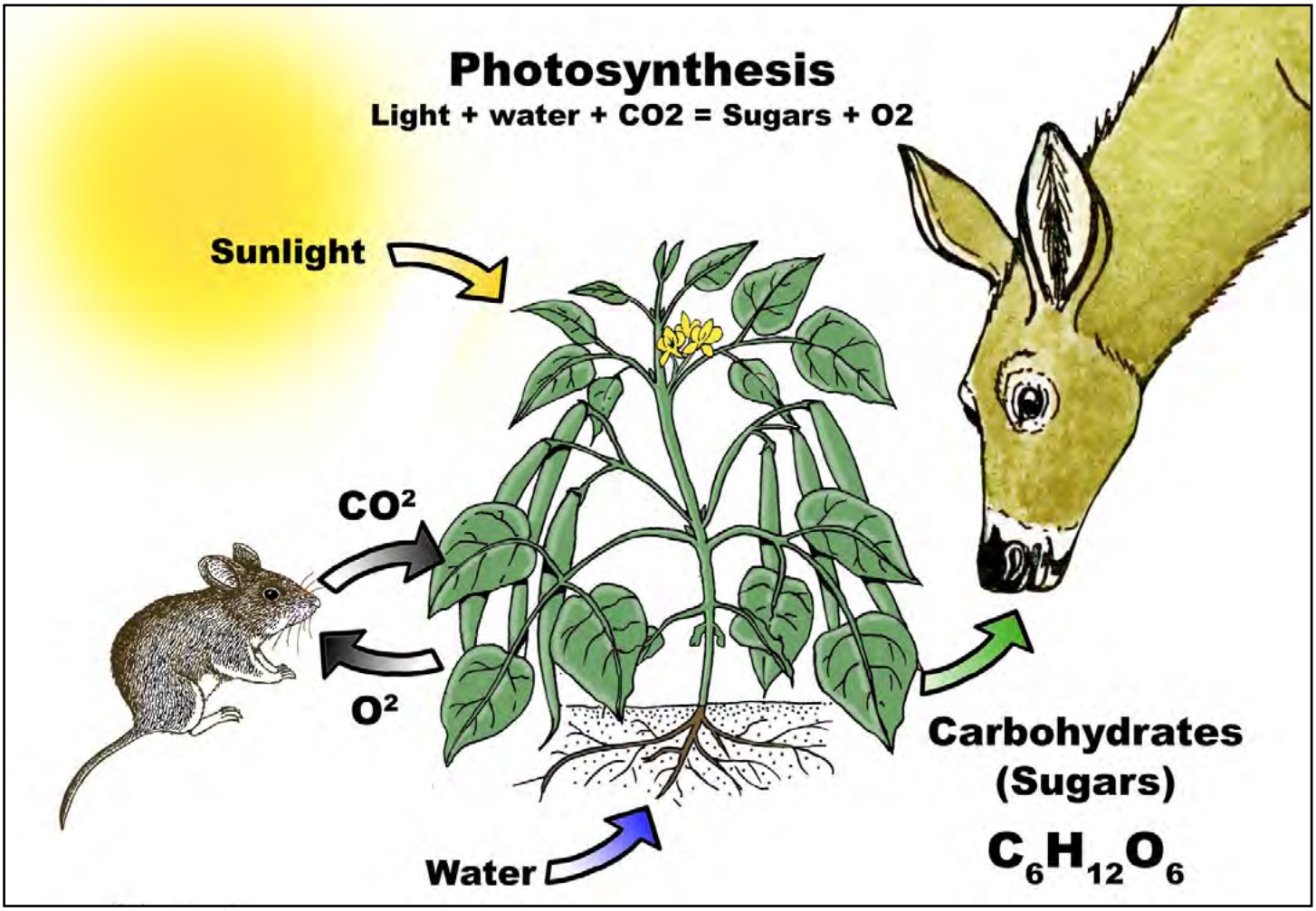
The leaf is the food-making part of a plant. Its structure is ideal for carrying out ***photosynthesis***. The top and bottom surfaces of a leaf protect the cells inside. ***Xylem*** (tubes that carry water up from the roots) and ***phloem*** (tubes that carry food made in the leaves around the plant) are found in veins inside the leaf. Underneath the leaf are small openings called ***stomata***. The stomata open and close to allow materials into and out of the leaf.

Chloroplasts are the parts (***organelles***) of plant cells, which contain ***chlorophyll.*** Chlorophyll is the green pigment that traps the light energy needed for photosynthesis to occur. The cells that contain the most chloroplasts are on the upper surface of a leaf exposed to the sun.

Carbon dioxide (CO_2) enters the leaf through the stomata. Water is absorbed by the roots and moves up to the leaf through the xylem. The energy absorbed by the chlorophyll helps to change the carbon dioxide and water into sugar (glucose) and oxygen (O_2). Oxygen is then released from the leaf through the stomata. Sugar then travels to other parts of the plant through the phloem. The plant uses the sugars to grow and reproduce.

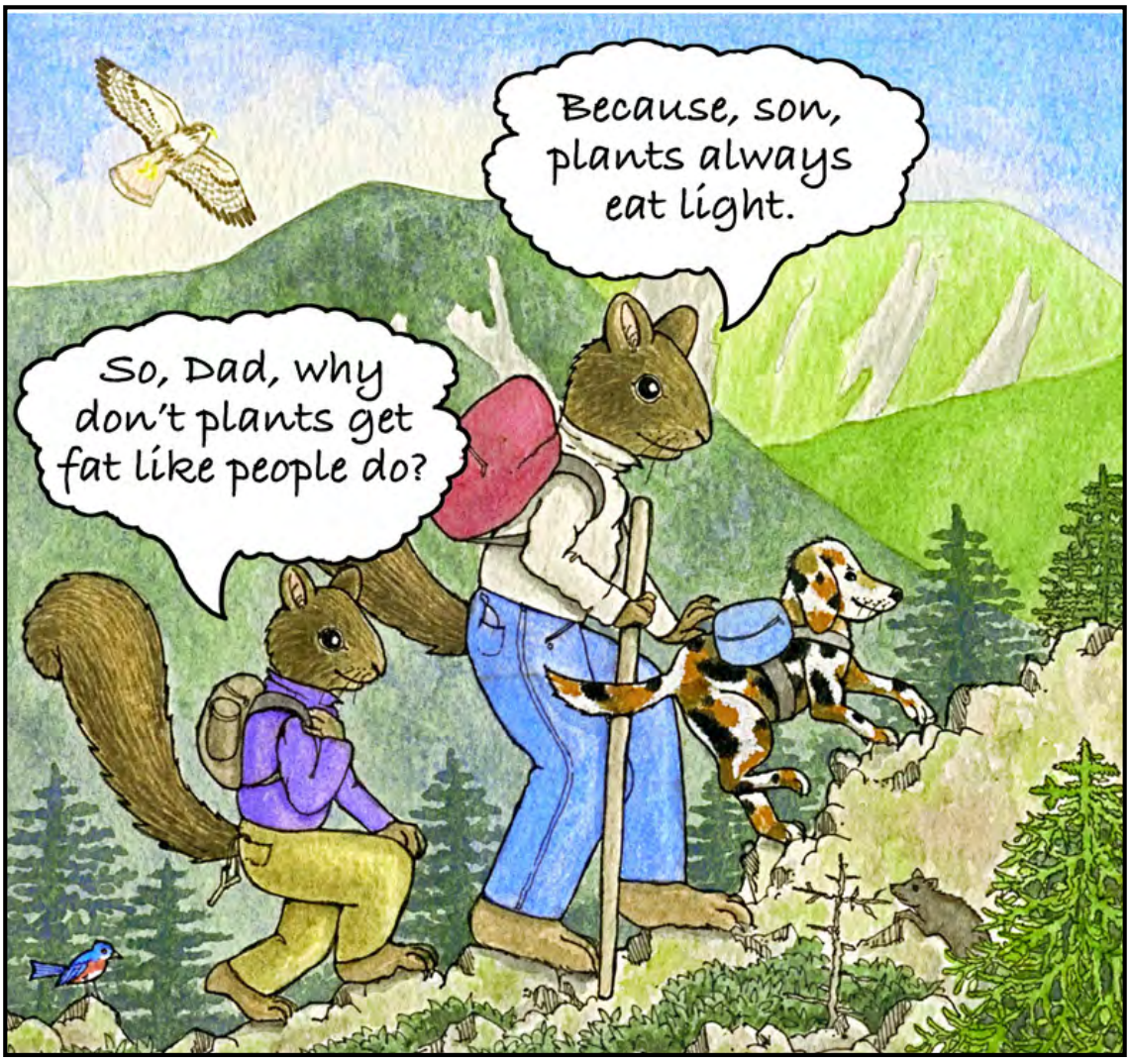
The formula for photosynthesis is: Light + water + CO_2 = Sugars + O_2

Look at the model below to see a visual image of the process of photosynthesis.



Comprehension Comic

Explain the humor in the following comic using a science concept.



Photosynthesis Reading - Vocabulary Assessment
Fill in the blanks using the vocabulary words below.

The leaf is the food-making part of a plant. Its structure is ideal for carrying out ***photosynthesis***. The top and bottom surfaces of a leaf protect the cells inside. _____ (tubes that carry water up from the roots) and _____ (tubes that carry food made in the leaves around the plant) are found in veins inside the leaf. Underneath the leaf are small openings called _____, which open and close to allow materials into and out of the leaf.

_____ are the parts (***organelles***) of plant cells, which contain ***chlorophyll.*** Chlorophyll is the green _____ that traps the light energy needed for photosynthesis to occur. The cells that contain the most chloroplasts are on the upper surface of a leaf exposed to the _____.

Carbon dioxide (CO_2) enters the leaf through the stomata. Water is absorbed by the _____ and moves up to the leaf through the xylem. The energy absorbed by the chlorophyll helps to change the carbon dioxide and water into sugar (glucose) and oxygen (O_2). Oxygen is then released from the leaf through the stomata. Sugar then travels to other parts of the plant through the phloem. The plant uses the sugars to _____ and reproduce.

The formula for photosynthesis is:

_____ + water + CO_2 = _____ + O_2

grow
light
pigment
phloem
roots
stomata
sugars
sun
xylem

Photosynthesis Reading Comprehension Quiz

Name: _____ Date: _____ Class: _____

1

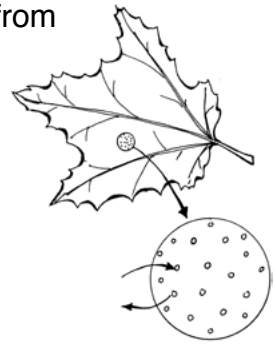
The part of the plant that does the most photosynthesis is the:

A leaves
B flowers
C roots
D fruit

2

The little openings in the leaves that collect carbon dioxide from the air and release oxygen are called:

A air holes
B vacuoles
C lungs
D stomata



3

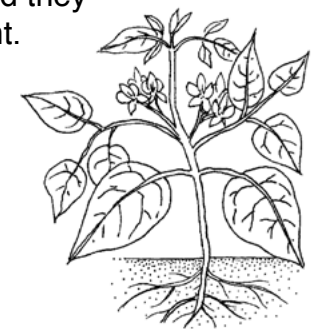
In the veins inside the leaves and stems of plants are tubes that carry water up from the roots called _____.

A phloem
B xylem
C chloroplasts
D stomata

4

Water and minerals are brought up from the _____, and they help anchor the plant.

A roots
B stem
C leaves
D flowers



5

The organelle in a plant cell that has the green pigment for photosynthesis is the _____.

A chloroplast
B stem
C chlorophyll
D stomata

6

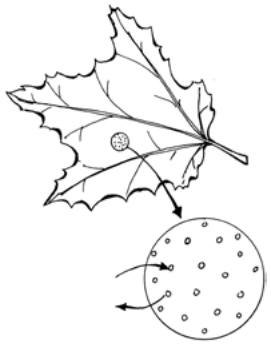
The formula for photosynthesis is:
_____ + water + CO_2 = sugars + O_2

A glucose
B light
C leaves
D oxygen

7

All the following things pass through the leaves' stomata except:

A carbon dioxide
B pollen
C oxygen
D water

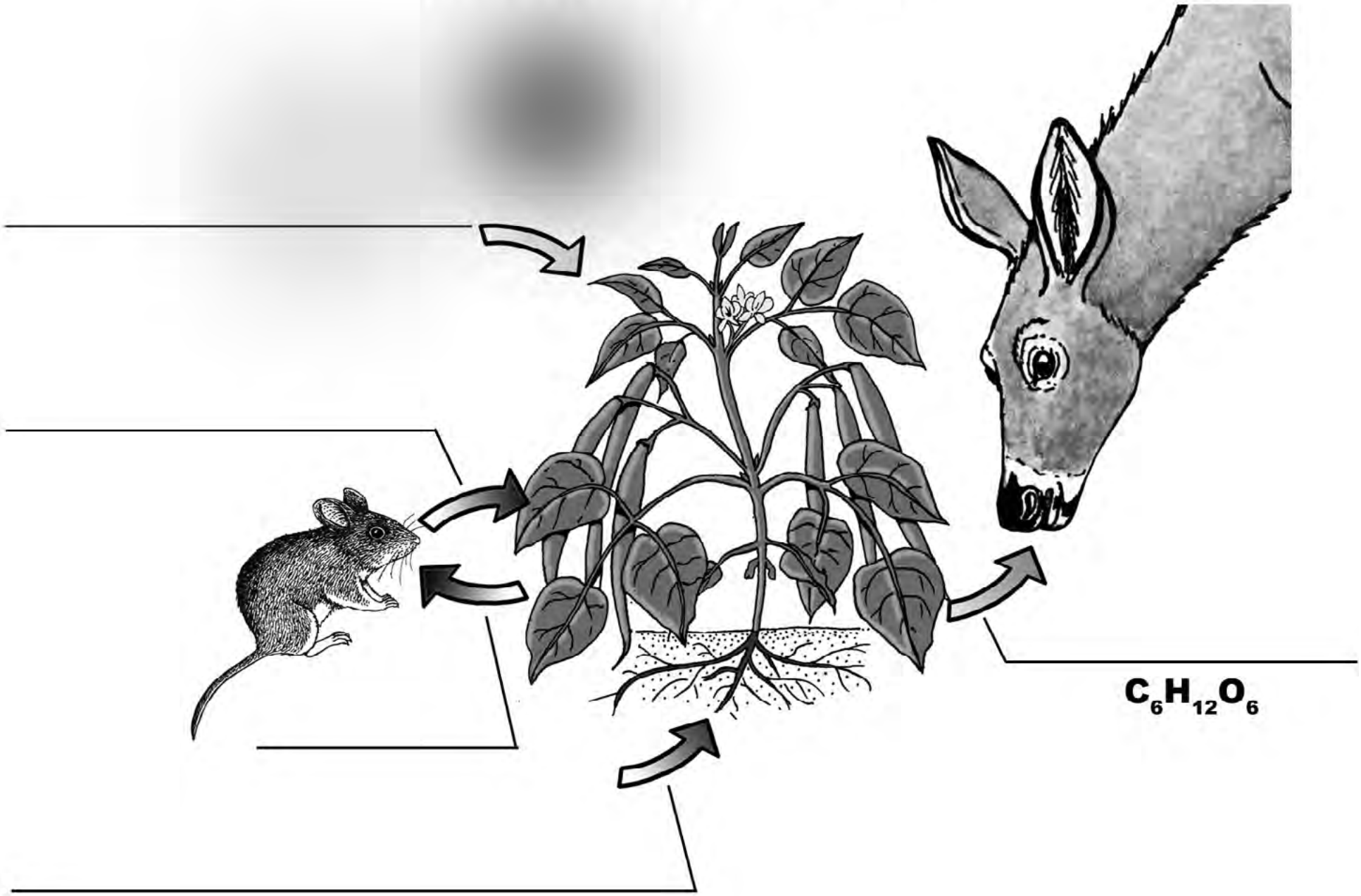


8

The stomata are found:

A on the root
B on the stem
C in the flowers
D under the leaves

Label the Parts of Photosynthesis



Introductory Experiment - The Elements of Photosynthesis

Goals: Students now know that for photosynthesis to occur, a plant needs sunlight, water and carbon dioxide. In the experiment, students will observe if plants can thrive without all three of the essential elements for photosynthesis – water, sunlight and carbon dioxide.

Materials:

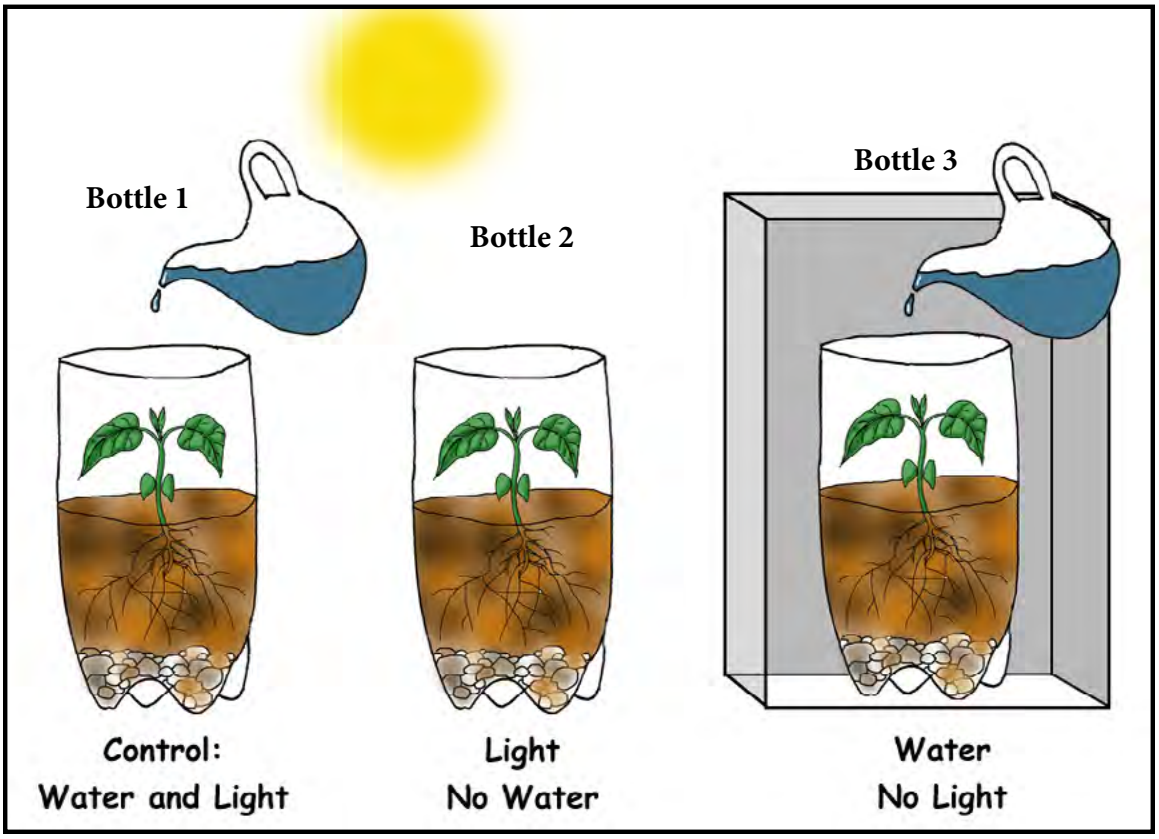
- three empty, peeled 2-liter bottles
- scissor
- scotch tape
- pitcher with water
- box in which the planter can fit (and a closet or dark cabinet in which to put bottle 3)

Procedures:

1. Cut the tops off the plastic bottles.
2. Dig up three small plants (about the same size) from the schoolyard with their surrounding dirt.
3. Place each into one of the 2-liter bottles.
4. Place two of the planters in the sunlight and one under a box in a closer, (so that it gets no sunlight).
6. One of the planters in the light will be Bottle 1 – the control bottle receiving water daily and sunlight. Bottle 2 (in the sunlight) gets no water. Bottle 3 (in the dark), gets watered every day, but receives no sunlight.
7. After 10 days, look at the terrariums side by side. ***Observation:*** *Can you see any differences between the plants?*

Thinking Moment: *Is this the result you expected? Explain and Discuss.*

Conclusions?



Name: _____ Date: _____

Authentic Performance - Volcanic Apocalypse

A huge volcanic eruption releases tons of dust into the air blocking out sunlight on Earth for a full year. As an ecologist, it is your job to predict what will happen if the Earth cannot receive sunlight for a full year. Name three effects you might expect to see happening to the planet over that amount of time with no sunlight.

1. _____

_____

2._____

_____

3._____

_____

Watch a Short Video on Photosynthesis:

LINK: **http://www.exploringnature.org/db/detail.php?dbID=41&detID=2098**

Answer Questions:

1) What living things can make energy using photosynthesis? _____

2) What pigment absorbs light for photosynthesis? _____

3) Besides for sunlight and water, what else is needed to make energy from photosynthesis? _____

Experiment - The Elements of Photosynthesis

Goals: For photosynthesis to occur, a plant needs sunlight, water and carbon dioxide. To see photosynthesis in action, we will observe how a green plant (elodea) uses sunlight to take in CO_2 and release O_2 (control). In addition, we will deny sunlight to another specimen, to observe how photosynthesis does not occur without sunlight. Follow the procedures below to complete this experiment.

Materials:

- (two per group) test tubes, stoppers, straws
- (one per group) wax pencil, scissors, eye droppers, measuring beaker
- specimens of elodea (from local pet store)
- light source (grow light or sunny window)
- bromothymol blue (BTB) as a CO_2 indicator
- tap water that has sat out for at least 24 hours (chlorine will evaporate)
- black construction paper and tape

Procedures:

Break students down into groups of 3-4 with each group getting a set of two test tubes. Students in each group should take turns completing each of the following steps in each group.

1. Measure 40ml of the prepared tap water into each of their two test tubes.
2. Using the eye dropper, add about 100 drops of the bromothymol blue into each of the test tubes.

Important Fact: *Bromothymol blue is used as an indictor for the presence of carbon dioxide.*

3. Using a separate straw for each test tube, mix the water and bromothymol blue in each of the test tubes (leaving the straws in each test tubes afterward). ***Thinking Moment:*** *How can you add CO_2 to the test tubes?*
4. Doing one test tube at a time, cover the top with a finger to prevent splashing and then gently blow carbon dioxide into the test tube through the straw until the liquid turns yellow. Discuss what the change in color indicates about the contents of the test tubes.
5. Cut a small sprig of elodea using scissors (make an angular cut in the stem) and place the plant bit in each of the test tubes. Then stopper them. Label each with the time, date and group number.
6. Add the words "no sun" to one of the test tubes using the wax pencil and wrap it with black construction paper, taping it in place so that no sunlight can get in.
7. Place both test tubes in a holder in front of a light source (sunny window or grow light) so that they both get the same amount of warmth even though one will get no light.

Thinking Moment: *Can you predict what will happen over the next few hours? Discuss.*

8. Several hours later (or next class period), have students remove the black paper from their test tube and compare the color of both liquids in the two test tubes.

Observation: *Explain what changed in the test tubes.*

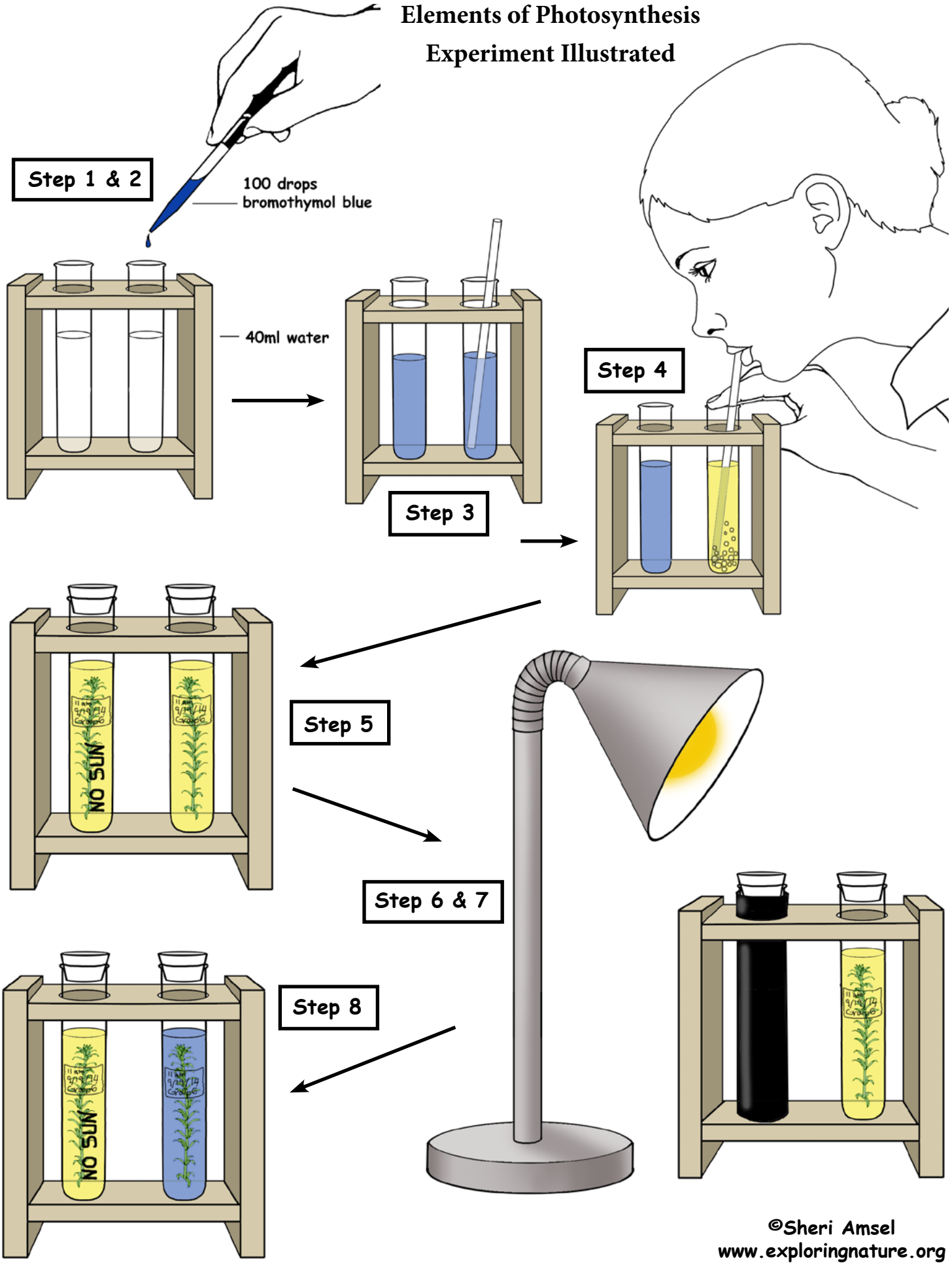
Critical Thinking:

A. *Explain what happened in this experiment.*

B. *Using the formula for photosynthesis explain how you simulated each part:*

water + CO_2 + sunlight = O_2 + glucose

Elements of Photosynthesis Experiment Illustrated



Name: _____ Date: _____ Class: _____

Experiment - The Elements of Photosynthesis Worksheet

1. How did blowing into the water and bromothymol blue provide one of the elements needed for photsynthesis?

_____

_____

2. How did adding the elodea (pond weed) to the test tube and setting it in front of light cause the color of the liquid to change?

_____

_____

3. Why did the liquid in the test tube covered in black paper not change color the way the uncovered liquid did?

_____

_____

4. Why did you have to wait for a few hours for the color change to occur?

_____

_____

5. Can you explain in your own words how this experiment demonstrated photosynthesis?

_____

_____

_____

_____

_____

KEY

Photosynthesis Reading Comprehension Quiz

1. A
2. D
3. B
4. A
5. A
6. B
7. B.
8. D

Vll. Summarize Knowledge - Enduring Understandings

1) Plants need sunlight, water and carbon dioxide to produce oxygen and energy (in the form of glucose).

2) The ability of plants to produce energy from the sun (water and CO_2) is the basis of all the food webs on Earth.

3) The ability of plants to produce oxygen from the sun (water and CO_2) is the basis of all oxygen breathing life on Earth.

MS.Matter and Energy in Organisms and Ecosystems

Disciplinary Core Ideas:

LS1.C Organization for matter and energy flow in organisms

• Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)

• Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

Crosscutting Concepts:

Cause and Effect

• Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

Energy and Matter

• Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7)

• Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)

• The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Stability and Change

• Small changes in one part of a system might cause large changes in another part. (MS-LS2-4)

Science and Engineering Practices:

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

• Develop a model to describe phenomena. (MS-LS2-3)

• Develop a model to describe unobservable mechanisms. (MS-LS1-7)

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

• Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

• Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-6)

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

• Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4)

Performance Expectations:

Students who demonstrate understanding can:

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

MS-LS1-7. **Develop a model** to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. *[Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]*

MS-LS2-1. **Analyze and interpret data** to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. *[Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]*

MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. *[Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]*

MS-LS2-4. **Construct an argument** supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. *[Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]*

Common Core State Standards Connections:

ELA/Literacy -

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3),(MS-LS1-4),(MS-LS1-5),(MS-LS1-6)

RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-5),(MS-LS1-6)

RI.6.8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-1)

WHST.6-8.1 Write arguments focused on discipline content. (MS-LS1-3),(MS-LS1-4)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-5),(MS-LS1-6)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-LS1-1)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-5),(MS-LS1-6)

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-2),(MS-LS1-7)

Mathematics -

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-6),(MS-LS2-3)