LESSON PLAN

"SEEING" PHOTOSYNTHESIS

Time Frame: Three 45-minute sessions

Learning Objectives:

- Gain a basic understanding of the multi-step process of photosynthesis.
- Know that plants make their own food from three components: water, energy from sunlight, and carbon dioxide.
- Measure the rate of photosynthesis through a hands-on experiment with spinach leaves.
- Demonstrate understanding by being able to explain the scientific process orally or through words and pictures.

Overview:

This lesson introduces the concept of photosynthesis, the process by which plants make their own food, and explores it in action through experimentation. Although photosynthesis can be explained in simple terms, it is a complex process at the molecular level. In order for middle school students to conceptualize this abstract process, it is important to simplify explanations and break the process down into steps. Many students and adults alike have misconceptions about how photosynthesis works, so it's a good idea to begin with the basics before diving straight into lab work.

Standards Alignment:

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.

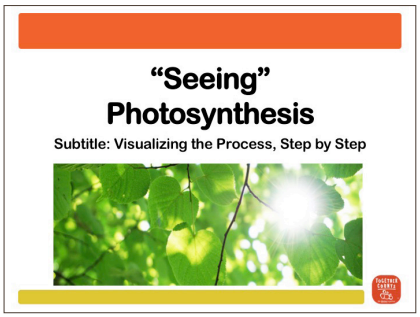
- LS1.C: Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.
- PS3.D: The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e. from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen.

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.

- LS1.C: 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.
- PS3.D: Cellular respiration in plants and animals involves chemical reactions that release stored energy and produce water and carbon dioxide.

Materials for Lesson Plan:

- PowerPoint deck
- Computer with Internet access and projector
- Copies of 3 Student Reference Sheets
- Copies of Student Worksheet
- Baking soda
- Water
- Liquid dish soap
- Measuring jug
- Measuring spoons
- Clear plastic cups
- One-hole punch or sturdy straw
- Spinach leaves
- 10-mL syringe (without needle)
- Light source (preferably a lightbulb clamped to a ring stand)
- Timer
- Graph paper and pencils



PPT Slide Example

Part A. Photosynthesis Video and Discussion

Teacher Preparation:
Download the PowerPoint deck in the Worksheets & Downloads section at the end of this lesson. The deck includes links to the following videos, which you can watch in advance to determine which ones you'd like to include, depending on grade level and time available. It also covers key vocabulary words and concepts students will use in the experiment and worksheets that follow.

Video: "Where Do Trees Get Their Mass From?" | Veritasium (4.09 mins)

Video: Photosynthesis | NOVA – PBS Learning Media (2.25 mins)

Video: Travel Deep Inside a Leaf | California Academy of Sciences (2.52 mins)

Video: Nature's Smallest Factory: The Calvin Cycle | TedED (5.37 mins)

Instructions:
Pass out copies of the Student Reference Sheets and Student Worksheet.

Begin the PowerPoint presentation. Refer to the PowerPoint script to see suggested places to pause in order for students to refer to their Reference Sheets and complete specific sections of their Worksheets.

Part B. Floating Leaf Disk Experiment

Time Frame: 45-minute session

Essential Questions:
How does light affect the rate of photosynthesis in leaves?

Teacher Notes:
It may save time to make a large batch of the bicarbonate solution for the class beforehand.
If individual timers are not available, have every group prepare their solutions and then put them under the light at the same time and use a class clock. In this case, you or an assistant can call out the minute marks.

Introduction:
Ask students to "fill in the blank" before beginning their experiment. "Plants get water from soil, energy from the sun, and carbon dioxide via tiny holes in the leaves called _____ [stomas]."
"Correct! In this experiment, we'll use water, sunlight and baking soda (bicarbonate ion) to serve as the carbon dioxide source."

Divide students into groups of 2–4 students.

Instructions to Students:
1. Prepare a 0.2% bicarbonate solution: For individual groups, combine 1/8 teaspoon of baking soda with 300 ml of water; for a larger batch, mix ½ teaspoon of baking soda with 900 ml of water. Add a few drops of liquid dish soap and mix gently — less if using a concentrated soap. Try to avoid soapsuds in the solution.
2. Pour this solution into a clear plastic cup, one for each group.
3. Use the single-hole punch, or a straw, to punch out 10 disks from the spinach leaf.
4. Take the plunger out of the syringe and remove any cover on the tip. Place the 10 disks into the syringe and tap the container until they are settled at the tip end. Then put the plunger back in, making sure not to damage any of the leaves.
5. Pull a small amount (less than 10 ml) of the solution from the cup into the syringe. Tap the syringe to get the leaves to float in the solution.
6. Carefully push any air out of the syringe with the plunger. Then put a finger over the tip and pull gently back on the syringe, creating a slight vacuum. Then swirl around the disks in the vacuumed solution.
7. This step can be repeated by each member of the group. Keep repeating until all of the disks have sunk to the bottom of the syringe.
8. Carefully remove the plunger and pour the solution and disks back into the clear cup.
9. Place the cup under a light source and start the timer — taking a reading of how many disks are floating at each minute. Record this data on your Student Worksheet.
10. Once all of the disks are floating (or if no new ones have risen in 5 minutes), put a card over the cup to completely block the light shining on the solution.
11. Continue taking readings of how many disks are floating until you have reached approximately 20 minutes, or until all of the disks have fallen back to the bottom. Record your data along the way on your Student Worksheet.
12. Now graph your data.
13. Compare and contrast. Did other groups have similar outcomes? How do the graphs compare?
14. Answer the questions on your Student Worksheet, either in class or as a homework assignment.

Discussion Points:
What causes the leaf disks to sink?
As the tiny air spaces in the leaf disks are replaced with water, the density increases. The denser the leaf disks get, the more they sink.

What causes the leaf disks to rise?
During the photosynthesis process, oxygen is released into the leaf disks, which causes them to rise.

How do we know photosynthesis is taking place?
Oxygen makes the circles float!

Assessment and Follow-Up:
Have students use their data from the experiment to create a graph, complete the worksheet and answer questions based on their results.

STEAM Project Extension

Write Your Own Children's Book
Students plan, write and illustrate a short children's science book to explain the process of photosynthesis to students in elementary school. It can be in the form of a story, a science book, or a comic strip (graphic novel style).

This project serves as a useful assessment tool, as it allows students to process what they've learned in order to teach others and demonstrate their understanding.

Materials for Lesson Plan:

- White paper for making storyboards
- Pencils, colored pencils, markers
- A variety of science picture books from your school or public library (see Recommended Children's Science Books at the end of this lesson)
- Two recommended books for read-alouds and reference:

Living Sunlight: How Plants Bring the Earth to Life
By Molly Bang and Penny Chisholm

Understanding Photosynthesis with Max Axiom, Super Scientist (Graphic Science)
by Liam O'Donnell, Charles Barnett III and Richard Dominguez

Preparation:
Check out a range of children's science books from your school or local library. See the list of recommended titles at the end of this lesson. Allow students time to read and share a stack of these books among themselves. Encourage them to look closely at the illustrations and to think about how the words and pictures work together to tell a story or explain a concept.

Instructions to Students:
1. Create a one-page storyboard to plan the sequence of your book and to map out the way the words and pictures will work together.
2. To create a storyboard, fold plain sheets of paper into four to six boxes, then crease the edges and unfold them.
3. Do a rough sketch of your book cover in the first box, followed by a quick picture and a few words in each of the boxes.
4. Once you've nailed down your story map, move on to write and illustrate your "story."

Tips to Remember:
In picture books, the text and illustrations work as equal partners to tell their story. The concept behind your drawings is more important than the execution. Stick figures are fine!

Use the following two books as examples that do an effective job of explaining photosynthesis — but in two very different ways. Ask for volunteers from the class to read sample children's books aloud to the class.

Guide for Reading *Living Sunlight* in Class
Artists can help us understand scientific concepts in new and different ways. In the book *Living Sunlight*, for instance, the illustrator created pictures to illuminate the scientific process of photosynthesis, something we cannot see with our own eyes. Working closely with a scientist, she came up with clever ways to depict things like atoms and molecules that teach us about their function and stick in our minds. The result is a book that help us to "see" the invisible process of photosynthesis.

Read this book aloud to the class, or ask for volunteers to help reading different pages. Be sure to hold the book up and walk around so that everyone can see the pages. This book has many illustrations that are more than what meets the eye, so you'll want to discuss the illustrations as you read. They serve as a visual explanation of the concept of photosynthesis. Pause for questions and ask students to describe what they see in the illustrations.

Discussion Questions:
(Adapted from the Science NetLinks, an education resource of the American Association for the Advancement of Science)

Read the first two pages out loud. Pause to ask students:
- Who is the narrator of this story? **(The sun.)**

Read two more pages. Pause to ask students:
- What are all these yellow dots? **(They are sunlight.)**
- What is in these yellow dots? **(The energy the sun makes is in the yellow dots.)**

Read the next four pages and pause to discuss the photosynthesis process. Talk students through the process using these questions:
- See the first illustration, the magnified image of the roots? What are the roots doing? **(They are sucking up water from the earth.)**
- Point to the second illustration. What's happening in this box? **(The plant is capturing energy from the sun.)**
- Point to the third illustration. What's happening here? **(Now the plant is using that light energy to split water molecules into hydrogen and oxygen.)**
- Point to the last illustration. What's happening here?

Read the next four pages.
How do plants use this glucose? **(They use it to grow and make seeds and fruits and flowers.)**

Read the next two pages.
- Since humans don't have leaves, how do we get energy from the sun? **(We eat the plants.)**

Read the next eight pages.
- Breathe in the air. Where are you getting this air or oxygen? **(We are getting it from plants.)**
- Breathe out. What are you breathing out? **(We are breathing out carbon dioxide.)**
- What happens to that carbon dioxide? **(The plants breathe it in and use it to make more food.)**

Read the last page.
- How do you know you have living sunlight inside you? **(You are warm… that's the sun's energy, processed through the breaking down of glucose. You move and breathe… using the sun's energy.)**

Now zoom in on illustrations:
pp 14-15 (plants with four rectangles)
The illustrations inside the four boxes show what's happening inside the leaves or roots of the green plant.

Box 1: "Plants suck up water—H2O—from the Earth."
This picture shows water molecules moving into the roots of the plant. **Throughout the book, the water molecules are easy to spot: They have a large white dot, the oxygen atom, and two small blue dots, the two hydrogen atoms.**

Box 2: "In daylight, green plants catch my energy with their chlorophyll."
The second rectangle — the one that looks like a vase — shows chlorophyll inside a leaf. **The chlorophyll is catching the sunlight-energy and is glowing from the captured light-energy.** This is more of a creative interpretation than the kind of drawing or diagram you'd find in a textbook. Now look at the Leaf Structure handout and compare this illustration of a leaf and chloroplast with the picture in this book. How are the two different?

Box 3: "Plants use my energy to break apart the water — they break the H2O into H and O2, hydrogen and oxygen."
The third rectangle shows the plant using the captured light-energy to **split water molecules** into oxygen and hydrogen. There are water molecules entering from the lower left. **The double white balls heading up are the oxygen molecules (O2) and the blue balls streaking down are hydrogen.** Ask students to point out the chloroplast, the water molecules, the oxygen molecules, and the hydrogen atoms.

Box 4: "But as plants break apart the water, they trap my energy as little packets."
The fourth rectangle shows the plant **trapping the captured light-energy in little "packets."** Ask students to describe what's happening in this picture.

Summarize what happened to the sunlight energy: **The sunlight energy was trapped by the chlorophyll in the leaves and now it's in the little packets.**

What happens next?
Summarize what else happened as the plant used sunlight energy to make the energy packets: **The plant pulled water up from the soil, split the water molecules, and released oxygen from the water into the air.**

Recommended Children's Science Books
These titles are included in the list of *Outstanding Children's Science Trade Books K-12 NSTA (National Science Teachers Association)*:

Because of an Acorn by Lola M. and Adam Schaefer, Illustrated by Frann Preston-Gannon
Beautifully illustrated story of interconnections in the forest ecosystem.

Botanicum by Kathy Willis, Illustrated by Katie Scott
Stunning artwork gives the impression of being in an art gallery as the reader learns details of both exotic and common plants in this oversize picture book.

Flotsam by David Wiesner

Living Sunlight: How Plants Bring the Earth to Life
By Molly Bang and Penny Chisholm

Natural World by Amanda Wood and Mike Jolley Illustrated by Owen Davey
This book allows the reader to create his/her own learning adventure while looking through stunning illustrations and a treasure trove of information about our natural world.

The Girl Who Thought in Pictures by Julia Finley Mosca, Illustrated by Daniel Rieley
A compelling story about the way Dr. Temple Grandin used her visual thinking to invent groundbreaking improvements in farming, especially animal care.

The Street Beneath My Feet by Charlotte Guillain, Illustrated by Yuval Zommer
Explore the world that exists beneath our feet, all the way to the inner core of Earth, as this book literally unfolds to 8 feet (2.4 meters)!

The Story of Seeds: From Mendel's Garden to Your Plate, and How There's More of Less to Eat Around the World by Nancy Castaldo
The impact of modern day science and technology ranging from genetically modified foods to the importance of maintaining seed vaults is examined from the context that seeds have an extremely important job in the world — the production of food.

Science Books with Creative Illustrations
Biology: Life as We Know It! by Dan Green (Author), Simon Basher

The Bacteria Book: The Big World of Really Tiny Microbes by Steve Mould

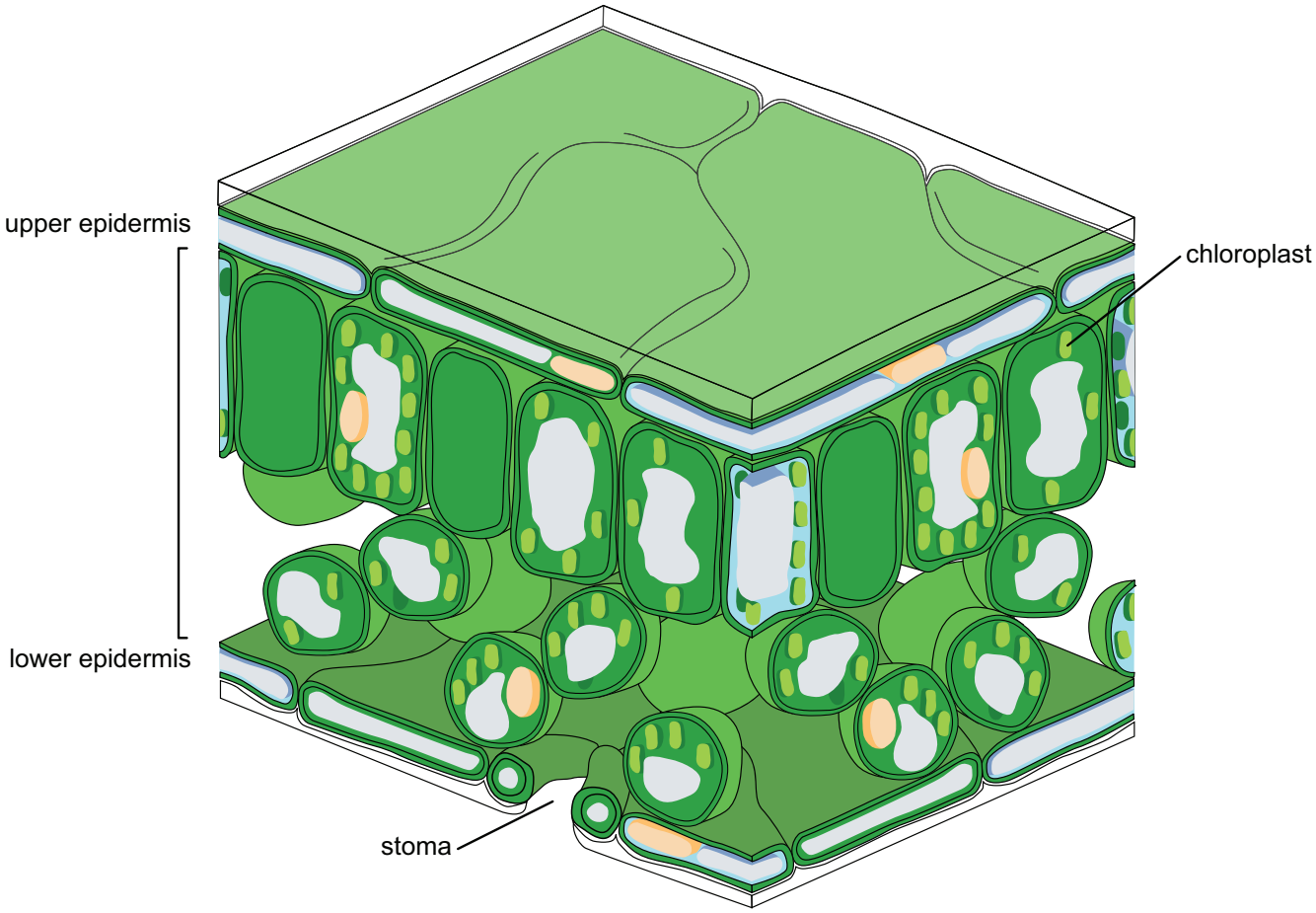
Visual Reference for Photosynthesis Project
Cells (Science Readers: Content and Literacy) by Teacher Created Materials

Nature Anatomy: The Curious Parts and Pieces of the Natural World by Julia Rothman

Worksheets & Downloads:

Student Reference Sheet #1:

Leaf Structures



A leaf has a number of special structures that play key roles in the process of photosynthesis:

- **Epidermis**: The outer layer of the leaf. It protects the delicate cells inside from unwanted pests, while still allowing the sunlight to reach the chloroplasts.
- **Chloroplasts**: The part of the leaf where photosynthesis occurs. They contain the very important chlorophyll as well as the other intricate structures that aid in the photosynthesis process.
- **Chlorophyll**: The thing that actually makes the photosynthesis reaction possible! It absorbs the energy from the light and uses it to spur on the photosynthesis reaction. It also has a green pigment, which gives plants their green color.
- **Stoma**: A very small opening in the epidermis of the leaf. These tiny holes are used to bring in the carbon dioxide needed for photosynthesis, and to expel oxygen gas and water vapor (the waste from the photosynthesis reaction).

Student Reference Sheet #2:

About Photosynthesis

"Ingredients" for Photosynthesis:
- Water
- Energy (from sunlight)
- Carbon dioxide (CO_2)

Photosynthesis "makes":
- Glucose
- Oxygen

How Do Plants Get Nourishment?

Humans, like all other animals, need to eat food for energy in order to survive. Plants, on the other hand, produce their own food through a process called **photosynthesis**.

Photosynthesis occurs in the leaves of plants and uses three components to make food:
1. **Water**, which is collected through the roots, travels up through the stem and into the leaves.
2. **Energy** from sunlight, which is absorbed by specialized compartments called chloroplasts in the leaves.
   - **Chloroplasts** also contain **chlorophyll**, which gives them their green color, and allow the plant to absorb energy from light.
3. **Carbon dioxide**, a gas that is abundant in air and gets into the leaves through tiny openings in the outer layer (**epidermis**) of the leaf called **stomas**.

The Chemical Reactions

The energy from sunlight splits the water molecules into **hydrogen** (H) and **oxygen** (O_2). Then the carbon atoms in CO_2 hook up with the hydrogen (H) atoms to form a new molecule called **glucose**. What happens to the oxygen after the split? The oxygen is released into the air through the **stomata** (tiny holes) of the leaf.

About Glucose

Glucose is a form of sugar that is used by plants and animals (and virtually all organisms on earth) as food. They break it down and use it to synthesize all the other molecules of life, like amino acids, vitamins and proteins. The plant may use the glucose molecule for food right away, or it may store it for later use.

The Carbon Cycle

When we eat a plant, the food we eat goes through a similar, but opposite process. We eat sugars such as glucose, breathe in oxygen, and take in water, both through drinking and breathing in water vapor. Those three elements go through their own chemical reaction which produces energy — the same energy stored by the plant through the process of photosynthesis! Besides the energy, the reaction also produces water and carbon dioxide. When we exhale we get rid of that carbon dioxide and water, which is later taken in by plants, and the cycle continues over and over.

The Food Chain

Photosynthesis is the foundation of all food chains. Essentially all living things owe their existence to this process.

Student Reference Sheet #3:

The Chemistry of Photosynthesis

All of the different processes that occur in organisms are in fact **chemical reactions**. These interactions between **molecules** of different substances are hard to visualize. So, to explain these reactions, scientists use a special format called a **chemical equation**. A chemical equation spells out which molecules are consumed in the reaction on one side, and which molecules are produced by the reaction on the other side, as well as the quantity of each of the molecules. It also includes the composition of each molecule by writing the number of each element's **atoms** in that molecule. This is called the molecule's **chemical formula**.

For example, water is written as H_2O — meaning, a water molecule has two hydrogen atoms (H) and one oxygen atom (O). For these reactions we will only be dealing with three elements: **hydrogen** (H), **oxygen** (O) and **carbon** (C).

Photosynthesis is the process of turning three ingredients — water, carbon dioxide and energy from sunlight — into glucose, which the plant uses for food.

- The chlorophyll in the chloroplasts uses the energy from the sunlight to break apart the water molecules into O2 and H, producing chemical energy and releasing oxygen.
- That energy is then used to combine carbon molecules from CO2 together to form molecules of glucose, which is a basic sugar that the plant uses for food to live and grow.

Glucose has a chemical formula of $C_6H_{12}O_6$. The process of photosynthesis produces not only glucose, but also waste in the form of oxygen gas (O_2) and water vapor (H_2O). The overall chemical equation for photosynthesis looks like this:

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

Or written out . . .

Six Molecules of Carbon Dioxide + Twelve Molecules of Water + Light Energy → One Molecule of Glucose + Six Molecules of Oxygen Gas + Six Molecules of Water Vapor

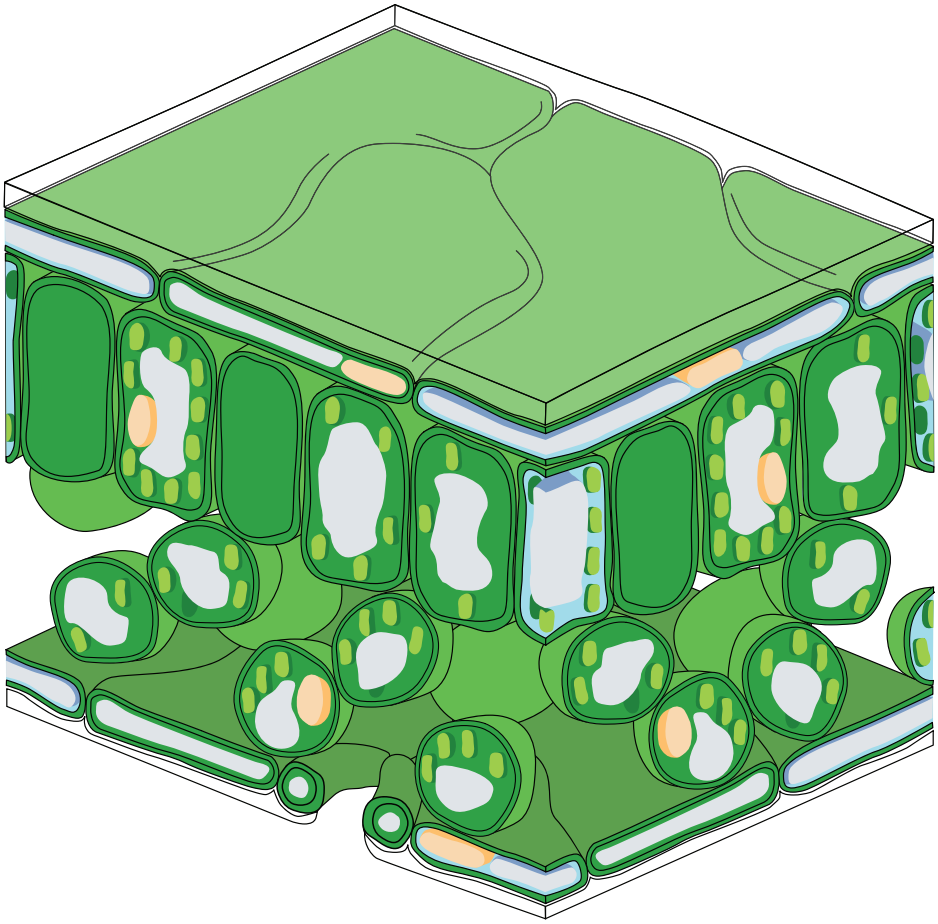
When humans or other animals eat a plant, we process the glucose (created via photosynthesis) as food for our own energy and growth. The glucose, along with the molecules of oxygen gas we breathe in from the atmosphere, undergo a chemical reaction of their own to release the energy from the glucose molecule for us to use. Like photosynthesis, this reaction creates waste in the form of carbon dioxide and water, both of which we exhale out of our lungs. The reaction looks like this:

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

Notice how similar this is to the chemical equation of photosynthesis? Plants and animals have been recycling each other's molecules for millions and millions of years!

Student Worksheet

Part 1. Zooming in on Leaf Structure



A. Label the leaf parts

Label the parts of the leaf with these vocabulary words:
Upper Epidermis, Lower Epidermis, Stoma, Chloroplast

B. Which part does what?

a. In which part of the leaf does photosynthesis occur? _____
b. What gas does a plant use in the process of photosynthesis? _____
c. How does that gas get into the leaf? Through the _____
d. In which part of the leaf is the pigment chlorophyll found? In the _____

Part 2. Floating Leaf Disk Experiment

A. Collect your data

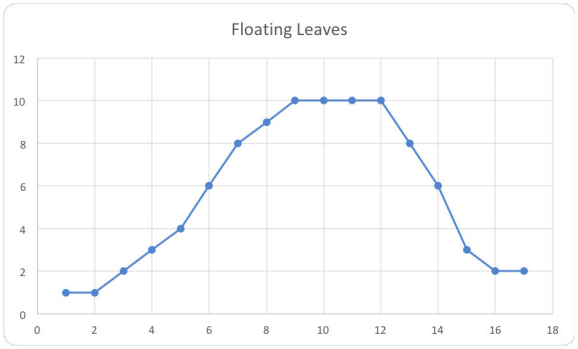
Collect data from your Floating Leaf Disk experiment and record it in this table:

Minutes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
# of Floating Leaves																				

B. Graph your data

Graph the number of leaves floating over time. Draw a thick vertical line at the time when you covered the light source. Connect your data points. (See example to the right.)

(Y-Axis = # of floating disks, X-Axis = minutes)



C. Observe and reflect

What trend do you notice from the data? _____

What is causing the leaves to float?_____

Why don't they all move at the same time? _____

_____

Why do the leaves start to drop when the cup is covered? _____

_____

D. Check your understanding

Plants get water from __ __ __ __, energy from the __ __ __ , and __ __ __ __ __ __ dioxide via tiny holes in the __ __ __ __ __ __ called stomas.

During the photosynthesis process, __ __ __ __ __ __ is released into the leaf circles, which causes them to rise.

E. Extra challenge

Do trees in the Northern Hemisphere perform photosynthesis all year long? Why do their leaves change color in the fall?

_____

When an animal eats meat, is it being kept alive by photosynthesis? Explain your answer.

_____

If plants suddenly went extinct, would the atmosphere contain less oxygen or more oxygen? Less carbon dioxide or more carbon dioxide? Why? Would this be good or bad for humans?

_____

Part 3. Chemical Reactions of Photosynthesis

What are the inputs to the photosynthesis reaction, written in their chemical form?

_____

What are the products of the reaction, written in their chemical form?

_____

Now, write out the full equation, and don't forget the quantities of each molecule.

_____

Write out the full chemical reaction that describes how humans "respire" — i.e. use oxygen to break down their food.

_____

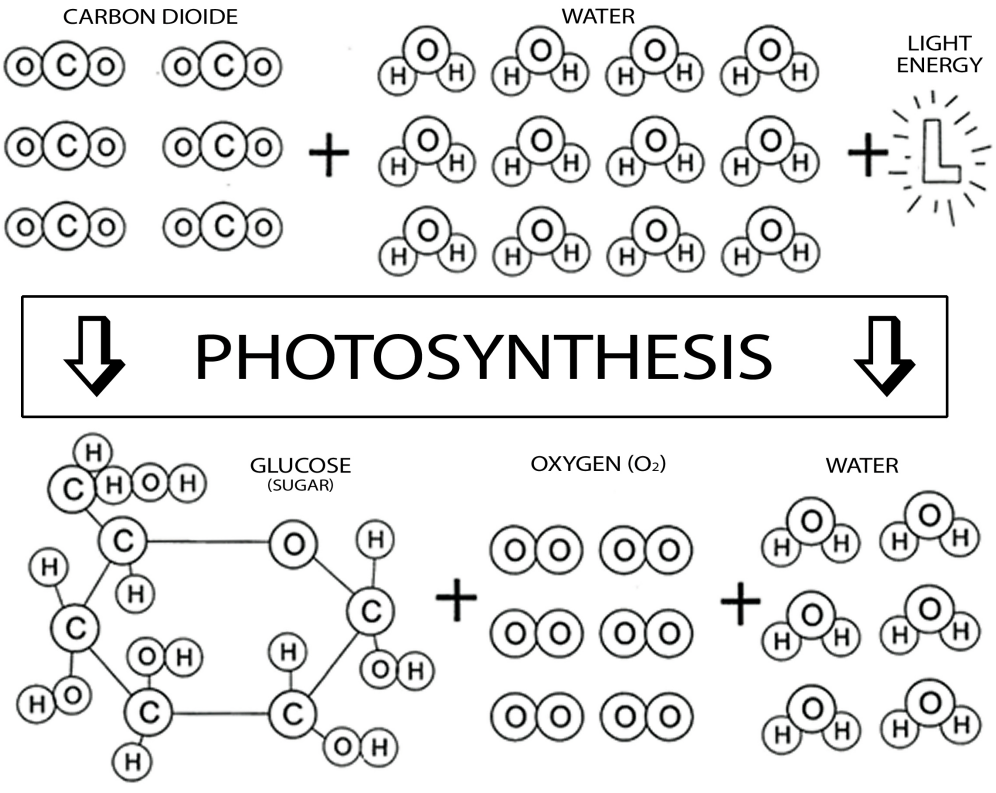
Look closely at the two reactions you just wrote out. What do you notice? _____

_____

Instructions:
Color in the chemical formula below:

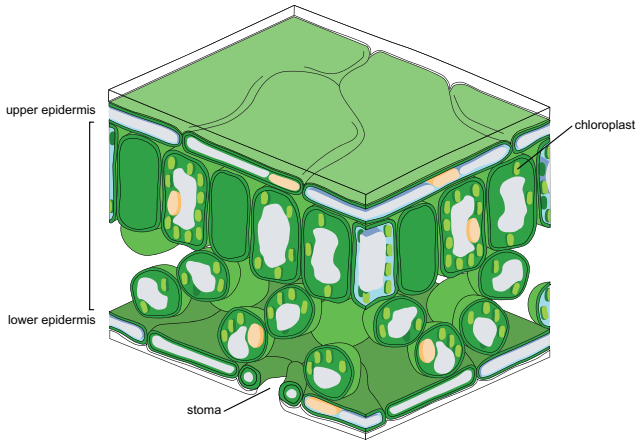
- Color in every H molecule in light blue pencil.
- Color in every C molecule in grey pencil.
- Color in the "L" (Light Energy) in yellow pencil.

(The O molecules will remain white.)



Student Worksheet – Answer Key
(Answer Key version)

Part 1. Zooming in on Leaf Structure



A. Label the leaf parts

Label the parts of the leaf with these vocabulary words:
Upper Epidermis, Lower Epidermis, Stoma, Chloroplast

B. Which part does what?

a. In which part of the leaf does photosynthesis occur?**[chloroplast]**
b. What gas does a plant use in the process of photosynthesis? **[carbon dioxide]**
c. How does that gas get into the leaf? **[through the stoma]**
d. In which part of the leaf is the pigment chlorophyll found? **[in the chloroplast]**

Part 2. Floating Leaf Disk Experiment

A. Collect your data

Collect data from your Floating Leaf Disk experiment and record it in this table:

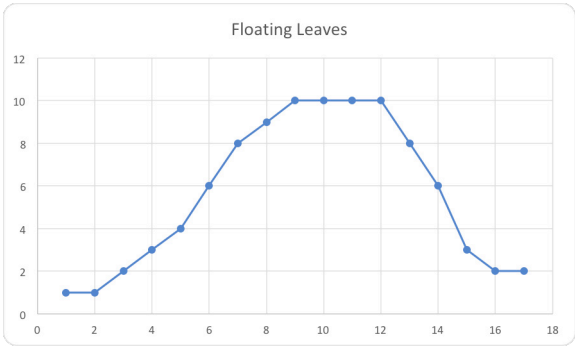
Minutes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
# of Floating Leaves																				

B. Graph your data

Graph the number of leaves floating over time. Draw a thick vertical line at the time when you covered the light source. Connect your data points.

Note that the following example shows a dramatic drop, whereas students' results might be more gradual or subtle.

(Y-Axis = # of floating disks, X-Axis = minutes)



Graph Example

C. Observe and reflect

What trend do you notice from the data? **[More leaves float the longer the light shines on them. Once the cup is covered, the number of leaves floating starts to drop.]**

What is causing the leaves to float? **[The oxygen gas, O2, being produced by photosynthesis.]**

Why don't they all move at the same time? **[Nothing in Nature is exactly the same. Each disk is photosynthesizing at a slightly different rate. So, some are fast, and some are slow... Just like when people run a race. They all start at the same time, but they get to the finish line at different times.]**

Why do the leaves start to drop when the cup is covered? **[Without the light, photosynthesis stops and the gas bubbles away — making the leaves again too heavy to float.]**

D. Check your understanding
Plants get water from **soil**, energy from the **sun**, and **carbon** dioxide via tiny holes in the **leaves** called stomas.

During the photosynthesis process, **oxygen** is released into the leaf disks, which causes them to rise.

E. Extra challenge
Do trees in the Northern Hemisphere perform photosynthesis all year long? Why do their leaves change color in the fall?
No. When their leaves change color they no longer have chlorophyll, which performs photosynthesis. So, the trees cannot perform photosynthesis until they grow new leaves in the spring. (Trees in the Tropics, however, can perform photosynthesis all year long.)

When an animal eats meat, is it being kept alive by photosynthesis? Explain your answer.
That animal got its energy to grow from plants or from other animals who ate plants. So, no matter what, the energy started in plants and got there via photosynthesis.

If plants suddenly went extinct, would the atmosphere contain less oxygen or more oxygen? Less carbon dioxide or more carbon dioxide? Why? Would this be good or bad for humans?
The planet would contain less oxygen and more carbon dioxide. Oxygen is a product of photosynthesis, which would no longer be produced. Plants take in carbon dioxide, which animals breathe out — so without plants there would be more of it. There is some surplus oxygen to keep us going for a while, but the more critical issue is carbon dioxide. There is so little CO2 in the atmosphere that tiny changes in sources make big and rapid differences. CO2 would build up quickly and cause warming, which would be bad for humans.

Part 3. Chemical Reactions of Photosynthesis

What are the inputs to the photosynthesis reaction, written in their chemical form? **[CO_2, H_2O, and light energy]**

What are the products of the reaction, written in their chemical form? **[$C_6H_{12}O_6$, O_2, H_2O]**

Now, write out the full equation, and don't forget the quantities of each molecule. **[6 CO_2 + 12 H_2O + (Light energy)→ $C_6H_{12}O_6$ + 6 O_2 + 6 H_2O]**

Write out the full chemical reaction that describes how humans "respire" – i.e. use oxygen to break down their food.
[$C_6H_{12}O_6$ + 6 O_2 → (Chemical energy) + 6 CO_2 + 6 H_2O]

Look closely at the two reactions you just wrote out. What do you notice? **[The two reactions are the same, but in reverse!]**