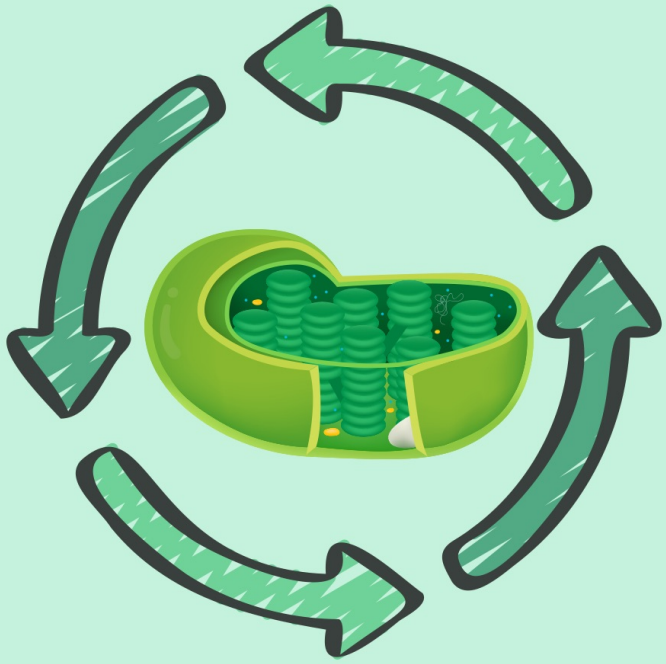
PHOTOSYNTHESIS

complete unit plan

Topics include:

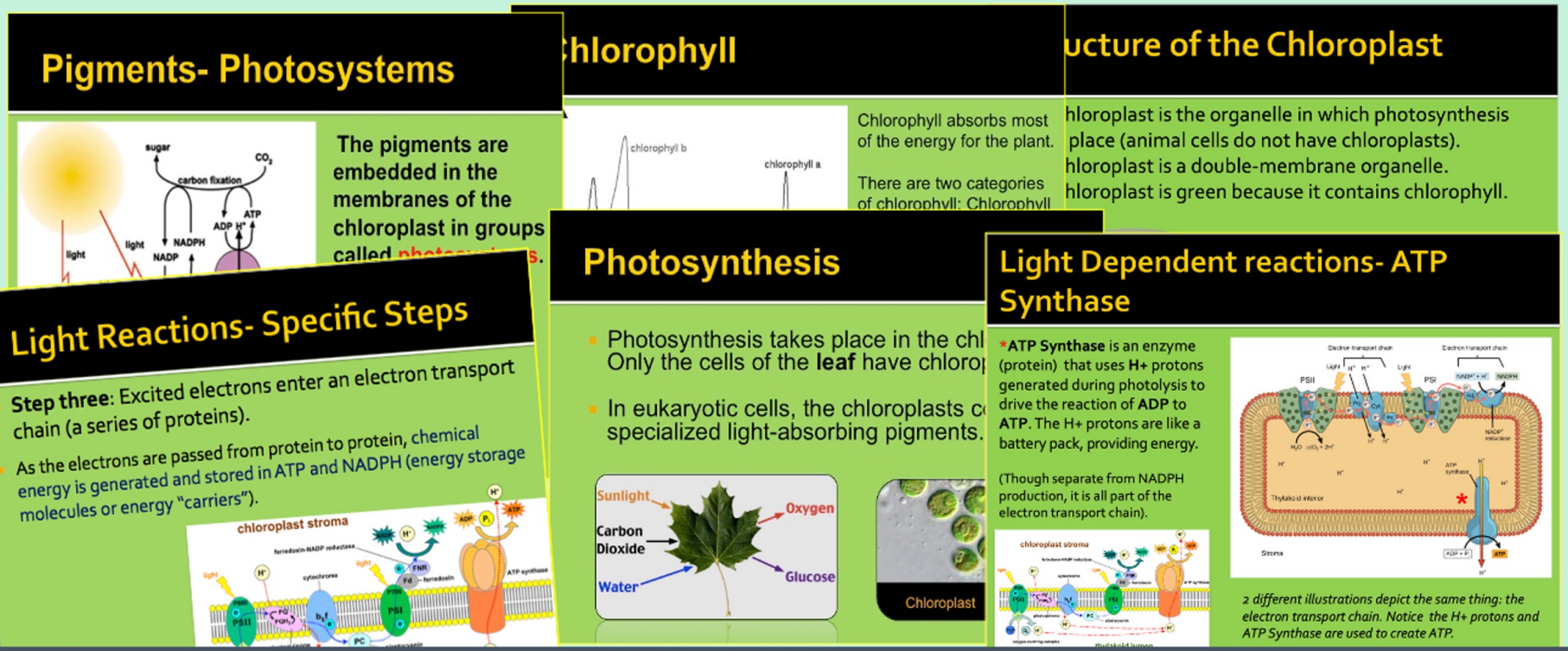
- ✅ Chloroplast structure
- ✅ Cells of the leaf
- ✅ ATP and Light
- ✅ Light dependent reactions
- ✅ Light independent-reactions



biology roots

Best for high school or middle school

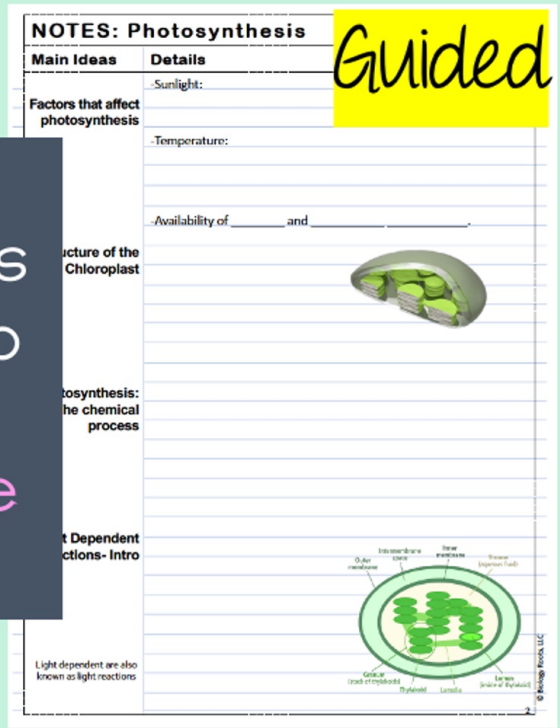
Editable, digital options, answer keys included!

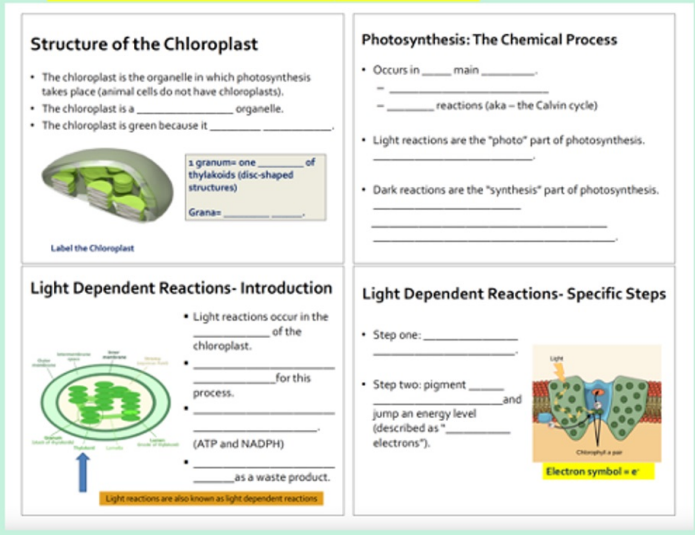


Editable PowerPoint Presentation

22 slides cover pigments, chloroplasts, reactions and factors that affect photosynthesis

The PowerPoint comes with 2 types of student notes to choose from: guided or fill in the blank





Photosynthesis ATLAS Activities

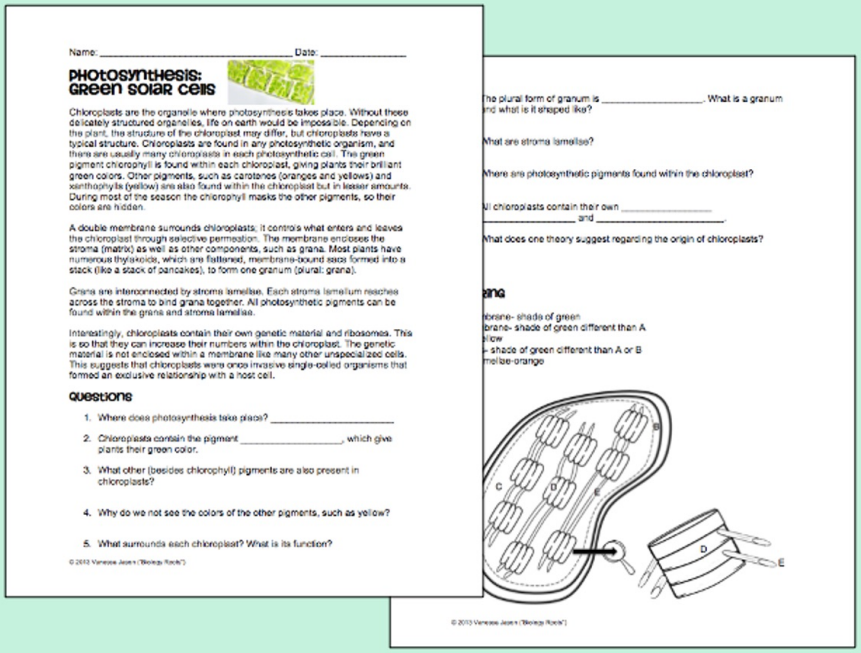
(Analyzing and Thinking Like A Scientist)

Guided Inquiry can be used in one of two ways:

1. As student-lead guided inquiry done in groups before teacher-lead instruction.

2. Or you can use what you'd like during traditional teacher-lead instruction.

CLASSWORK (most is editable). Answer keys always included.



Name: _____ Date: _____

PHOTOSYNTHESIS: GREEN SOLAR CELLS

Chloroplasts are the organelle where photosynthesis takes place. Without these delicately structured organelles, life on earth would be impossible. Depending on the plant, the structure of the chloroplast may differ, but chloroplasts have a typical structure. Chloroplasts are found in any photosynthetic organism, and there are usually many chloroplasts in each photosynthetic cell. The green pigment chlorophyll is found within each chloroplast, giving plants their brilliant green colors. Other pigments, such as carotenes (oranges and yellows) and xanthophylls (yellow) are also found within the chloroplast but in lesser amounts. During most of the season the chlorophyll masks the other pigments, so their colors are hidden.

A double membrane surrounds chloroplasts; it controls what enters and leaves the chloroplast through selective permeation. The membrane encloses the stroma (matrix) as well as other components, such as grana. Most plants have numerous thylakoids, which are flattened, membrane-bound sacs formed into a stack (like a stack of pancakes), to form one granum (plural: grana).

Grana are interconnected by stroma lamellae. Each stroma lamellum reaches across the stroma to bind grana together. All photosynthetic pigments can be found within the grana and stroma lamellae.

Interestingly, chloroplasts contain their own genetic material and ribosomes. This is so that they can increase their numbers within the chloroplast. The genetic material is not enclosed within a membrane like many other unspecialized cells. This suggests that chloroplasts were once invasive single-celled organisms that formed an exclusive relationship with a host cell.

Questions

1. Where does photosynthesis take place? _____
2. Chloroplasts contain the pigment _____, which give plants their green color.
3. What other (besides chlorophyll) pigments are also present in chloroplasts?
4. Why do we not see the colors of the other pigments, such as yellow?
5. What surrounds each chloroplast? What is its function?

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The plural form of granum is _____. What is a granum and what is it shaped like?

What are stroma lamellae?

Where are photosynthetic pigments found within the chloroplast?

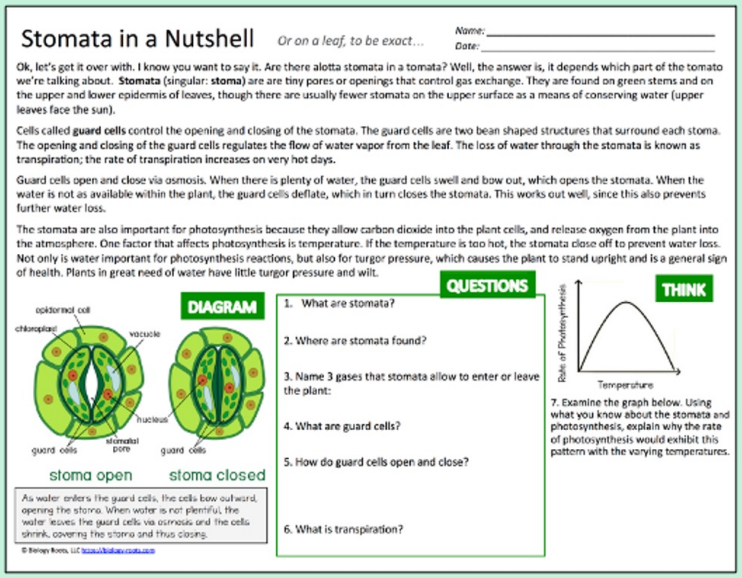
...l chloroplasts contain their own _____ and _____.

What does one theory suggest regarding the origin of chloroplasts?

...ana

...lorsine- shade of green
...brane- shade of green different than A
...llow
...- shade of green different than A or B
...mellae-orange

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Stomata in a Nutshell *Or on a leaf, to be exact...*

Name: _____
Date: _____

Ok, let's get it over with. I know you want to say it. Are there alotta stomata in a tomata? Well, the answer is, it depends which part of the tomato we're talking about. **Stomata** (singular: **stoma**) are are tiny pores or openings that control gas exchange. They are found on green stems and on the upper and lower epidermis of leaves, though there are usually fewer stomata on the upper surface as a means of conserving water (upper leaves face the sun).

Cells called **guard cells** control the opening and closing of the stomata. The guard cells are two bean shaped structures that surround each stoma. The opening and closing of the guard cells regulates the flow of water vapor from the leaf. The loss of water through the stomata is known as transpiration; the rate of transpiration increases on very hot days.

Guard cells open and close via osmosis. When there is plenty of water, the guard cells swell and bow out, which opens the stomata. When the water is not as available within the plant, the guard cells deflate, which in turn closes the stomata. This works out well, since this also prevents further water loss.

The stomata are also important for photosynthesis because they allow carbon dioxide into the plant cells, and release oxygen from the plant into the atmosphere. One factor that affects photosynthesis is temperature. If the temperature is too hot, the stomata close off to prevent water loss. Not only is water important for photosynthesis reactions, but also for turgor pressure, which causes the plant to stand upright and is a general sign of health. Plants in great need of water have little turgor pressure and wilt.

DIAGRAM

stoma open stoma closed

As water enters the guard cells, the cells bow outward, opening the stoma. When water is not plentiful, the water leaves the guard cells via osmosis and the cells shrink, covering the stoma and thus closing.

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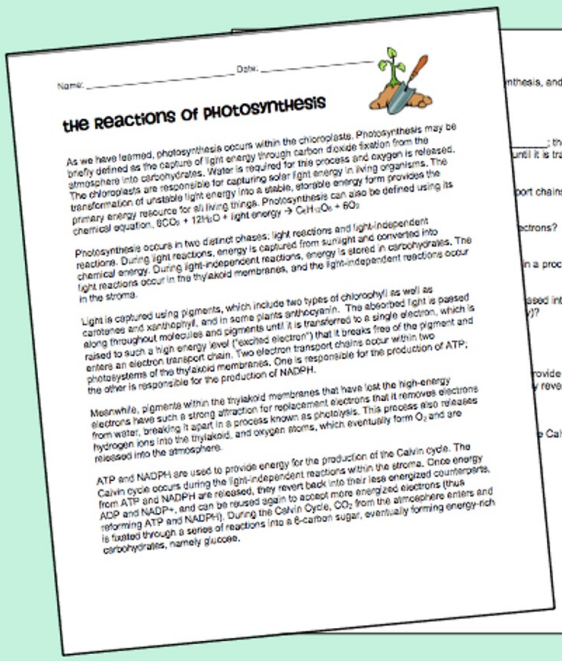
QUESTIONS

1. What are stomata?
2. Where are stomata found?
3. Name 3 gases that stomata allow to enter or leave the plant:
4. What are guard cells?
5. How do guard cells open and close?
6. What is transpiration?

THINK

7. Examine the graph below. Using what you know about the stomata and photosynthesis, explain why the rate of photosynthesis would exhibit this pattern with the varying temperatures.

Reactions of Photosynthesis Classwork (reading and coloring; light and dark reactions)



Name: _____ Date: _____

THE REACTIONS OF PHOTOSYNTHESIS

As we have learned, photosynthesis occurs within the chloroplasts. Photosynthesis may be briefly defined as the capture of light energy through carbon dioxide fixation from the atmosphere into carbohydrates. Water is required for this process and oxygen is released. The chloroplasts are responsible for capturing solar light energy in living organisms. The transformation of unstable light energy into a stable, storable energy form provides the primary energy resource for all living things. Photosynthesis can also be defined using its chemical equation: $6CO_2 + 12H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6O_2$

Photosynthesis occurs in two distinct phases: light reactions and light-independent reactions. During light reactions, energy is captured from sunlight and converted into chemical energy. During light-independent reactions, energy is stored in carbohydrates. The light reactions occur in the thylakoid membranes, and the light-independent reactions occur in the stroma.

Light is captured using pigments, which include two types of chlorophyll as well as carotenes and xanthophyll, and in some plants anthocyanin. The absorbed light is passed along throughout molecules and pigments until it is transferred to a single electron, which is raised to such a high energy level ("excited electron") that it breaks free of the pigment and enters an electron transport chain. Two electron transport chains occur within two photosystems of the thylakoid membranes. One is responsible for the production of ATP; the other is responsible for the production of NADPH.

Meanwhile, pigments within the thylakoid membranes that have lost the high-energy electrons have such a strong attraction for replacement electrons that it removes electrons from water, breaking it apart in a process known as photolysis. This process also releases hydrogen ions into the thylakoid, and oxygen atoms, which eventually form O_2 and are released into the atmosphere.

ATP and NADPH are used to provide energy for the production of the Calvin cycle. The Calvin cycle occurs during the light-independent reactions within the stroma. Once energy from ATP and NADPH are released, they revert back into their less energized counterparts, ADP and $NADP^+$, and can be reused again to accept more energized electrons (thus reforming ATP and NADPH). During the Calvin Cycle, CO_2 from the atmosphere enters and is fixated through a series of reactions into a 6-carbon sugar, eventually forming energy-rich carbohydrates, namely glucose.

...nthesis, and where does each phase

_____; the absorbed light is passed ...until it is transferred to a single

...port chains?

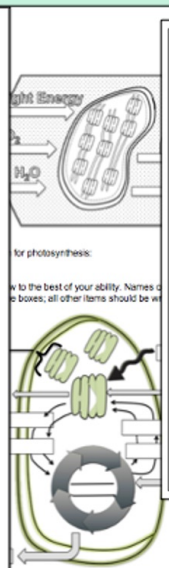
...ectrons?

...in a process known as

...ased into the atmosphere? What is the ...)?

...rovide energy for the production of the ...y revert back to _____ and

...e Calvin cycle?



for photosynthesis:

...w to the best of your ability. Names ...e boxes; all other items should be w...

Photosynthesis Practice

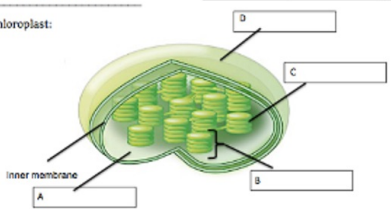
Name: _____ Date: _____

1. Write the equation for photosynthesis:

2. Fill out the table accordingly, listing the products and reactions of each phase.

	Reactions	Products
Light reactions		
Dark reactions		

3. Where do the light reactions occur?
_____
4. Where do the dark reactions occur?
_____
5. Label the chloroplast:



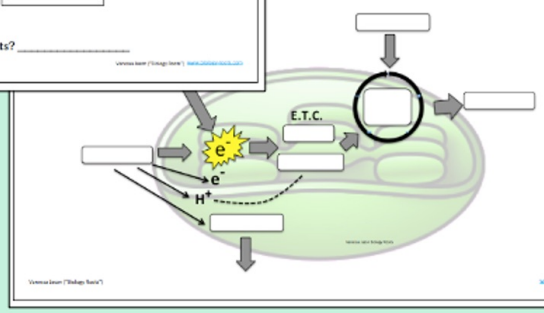
6. Which part of the plant contains cells that have chloroplasts? _____

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...wn in a process called _____.

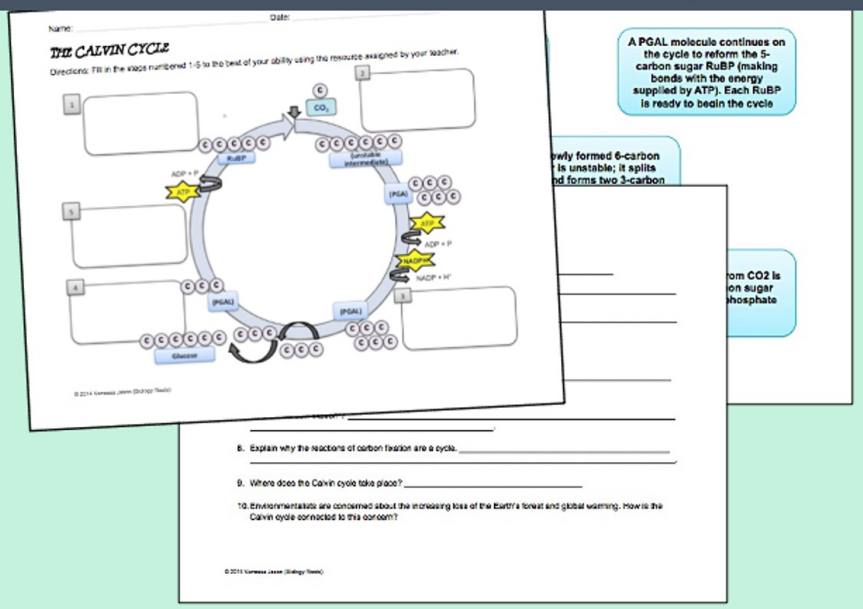
...ly? _____.

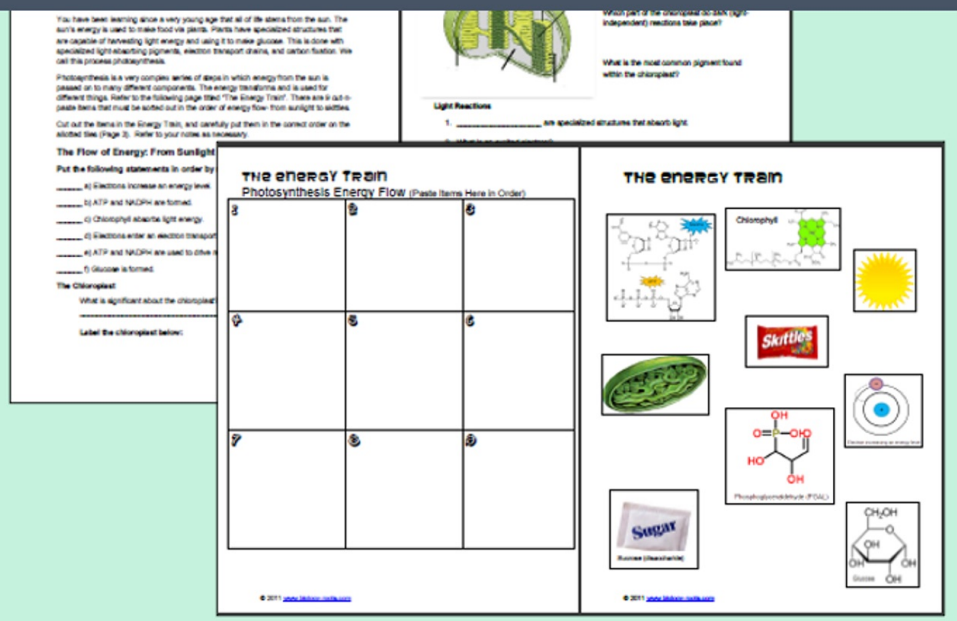
...e fill-ins can be products, reactants, or processes.



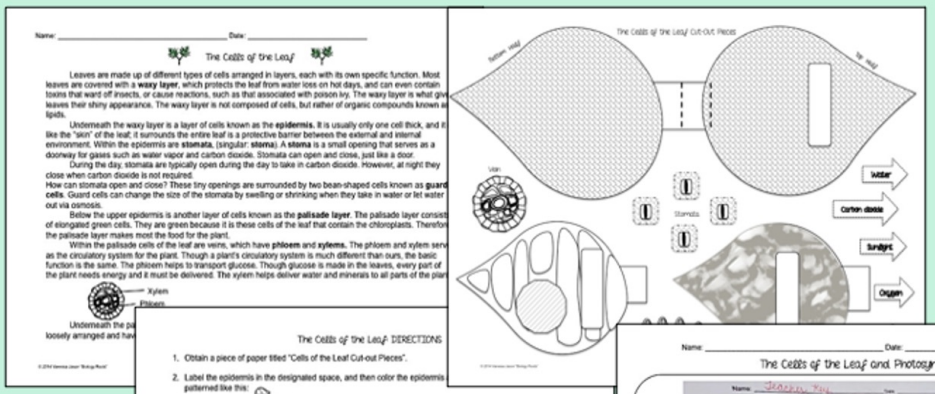
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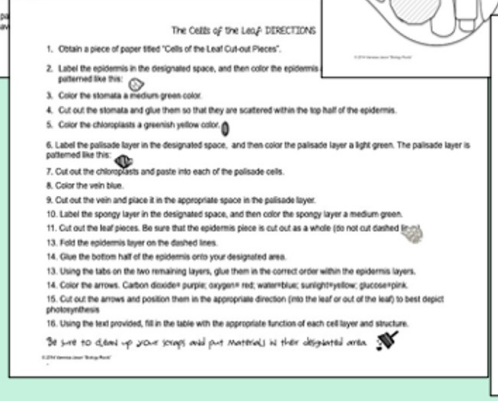
Reactions of Photosynthesis Classwork

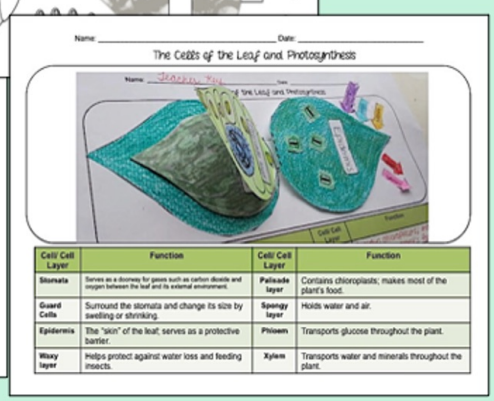


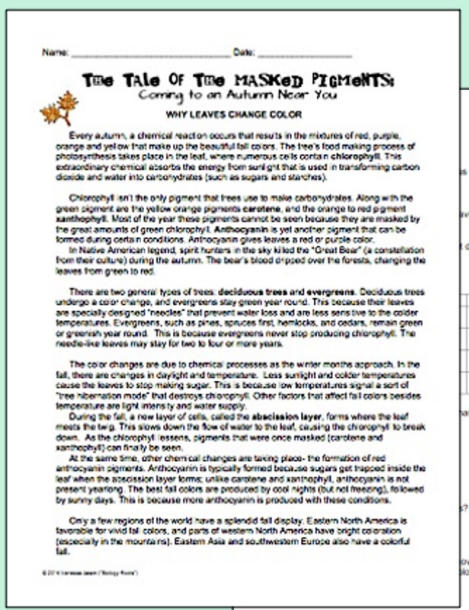


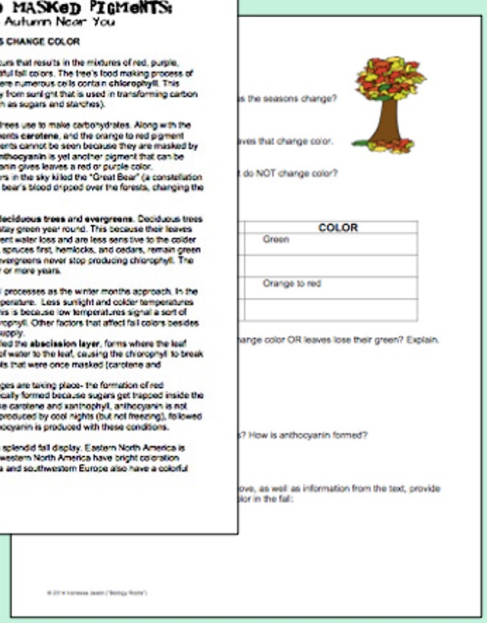
Cells of the Leaf | Why leaves Change Color

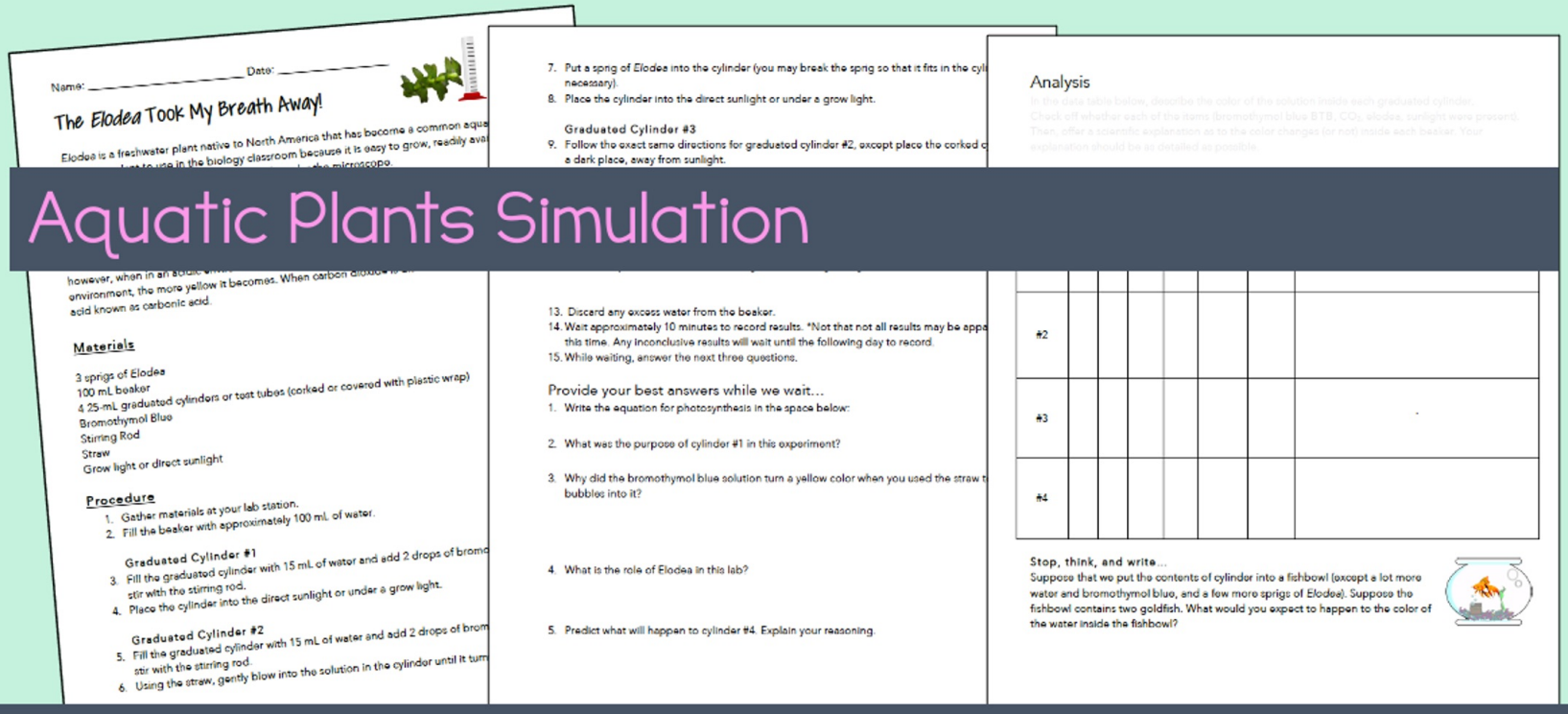











Name: _____ Date: _____

The Elodea Took My Breath Away!

Elodea is a freshwater plant native to North America that has become a common aqua

Materials

3 sprigs of Elodea
100 mL beaker
4 25-mL graduated cylinders or test tubes (corked or covered with plastic wrap)
Bromothymol Blue
Stirring Rod
Straw
Grow light or direct sunlight

Procedure

1. Gather materials at your lab station.
2. Fill the beaker with approximately 100 mL of water.

Graduated Cylinder #1

3. Fill the graduated cylinder with 15 mL of water and add 2 drops of bromo
4. Place the cylinder into the direct sunlight or under a grow light.

Graduated Cylinder #2

5. Fill the graduated cylinder with 15 mL of water and add 2 drops of brom
6. Using the straw, gently blow into the solution in the cylinder until it turn

7. Put a sprig of *Elodea* into the cylinder (you may break the sprig so that it fits in the cyli
8. Place the cylinder into the direct sunlight or under a grow light.

Graduated Cylinder #3

9. Follow the exact same directions for graduated cylinder #2, except place the corked c

13. Discard any excess water from the beaker.
14. Wait approximately 10 minutes to record results. *Not that not all results may be appe
15. While waiting, answer the next three questions.

Provide your best answers while we wait...

1. Write the equation for photosynthesis in the space below:
2. What was the purpose of cylinder #1 in this experiment?
3. Why did the bromothymol blue solution turn a yellow color when you used the straw t
4. What is the role of Elodea in this lab?
5. Predict what will happen to cylinder #4. Explain your reasoning.

Analysis

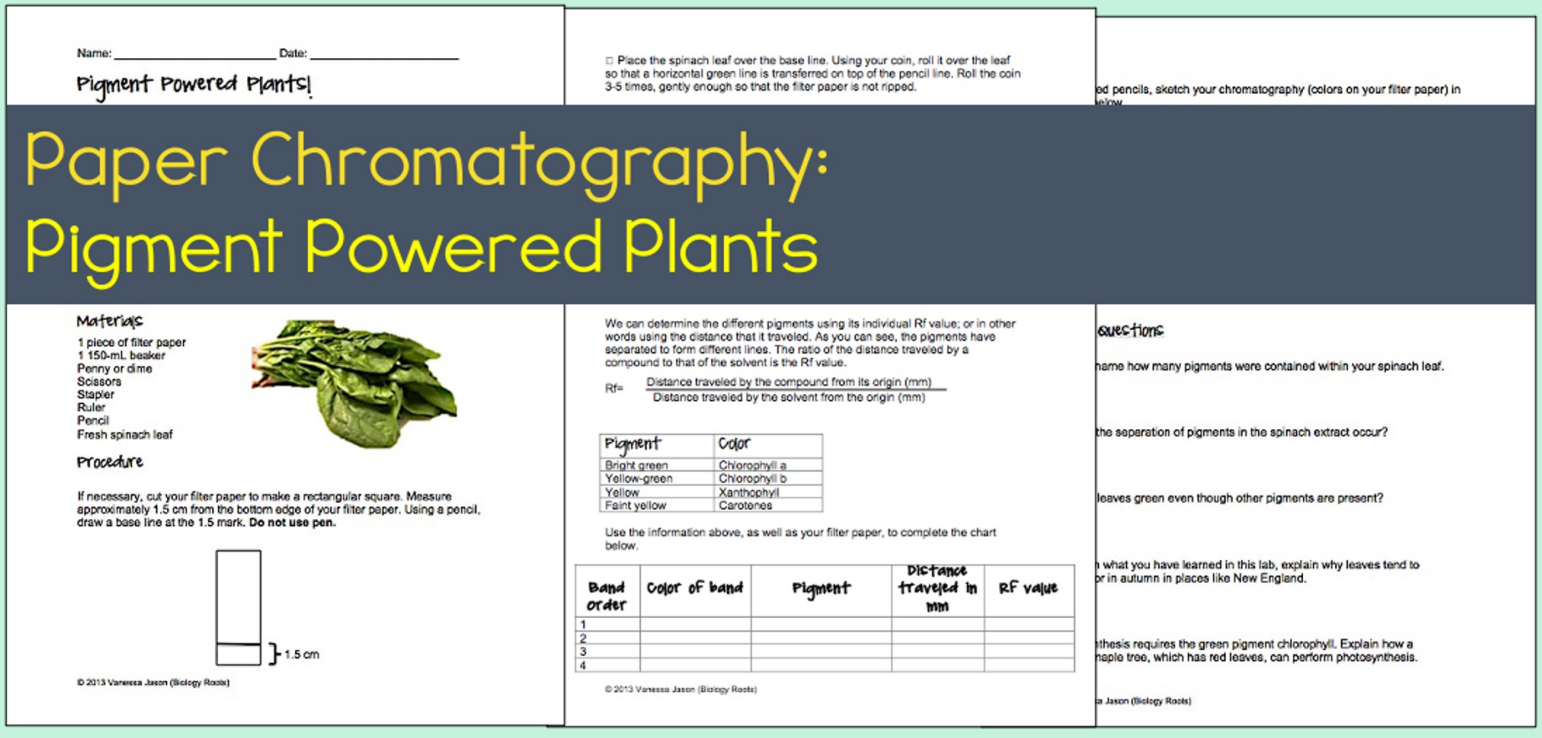
#2							
#3							
#4							

Stop, think, and write...
Suppose that we put the contents of cylinder into a fishbowl (except a lot more water and bromothymol blue, and a few more sprigs of *Elodea*). Suppose the fishbowl contains two goldfish. What would you expect to happen to the color of the water inside the fishbowl?

Aquatic Plants Simulation

Photosynthesis Lab Activities




Name: _____ Date: _____

Pigment Powered Plants!

Materials

1 piece of filter paper
1 150-mL beaker
Penny or dime
Scissors
Stapler
Ruler
Pencil
Fresh spinach leaf

Procedure

If necessary, cut your filter paper to make a rectangular square. Measure approximately 1.5 cm from the bottom edge of your filter paper. Using a pencil, draw a base line at the 1.5 mark. **Do not use pen.**

1.5 cm

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□ Place the spinach leaf over the base line. Using your coin, roll it over the leaf so that a horizontal green line is transferred on top of the pencil line. Roll the coin 3-5 times, gently enough so that the filter paper is not ripped.

We can determine the different pigments using its individual Rf value; or in other words using the distance that it traveled. As you can see, the pigments have separated to form different lines. The ratio of the distance traveled by a compound to that of the solvent is the Rf value.

$$Rf = \frac{\text{Distance traveled by the compound from its origin (mm)}}{\text{Distance traveled by the solvent from the origin (mm)}}$$

Pigment	Color
Bright green	Chlorophyll a
Yellow-green	Chlorophyll b
Yellow	Xanthophyll
Faint yellow	Carotenes

Use the information above, as well as your filter paper, to complete the chart below.

Band order	Color of band	Pigment	Distance traveled in mm	Rf value
1				
2				
3				
4				

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ed pencils, sketch your chromatography (colors on your filter paper) in

questions

name how many pigments were contained within your spinach leaf.

the separation of pigments in the spinach extract occur?

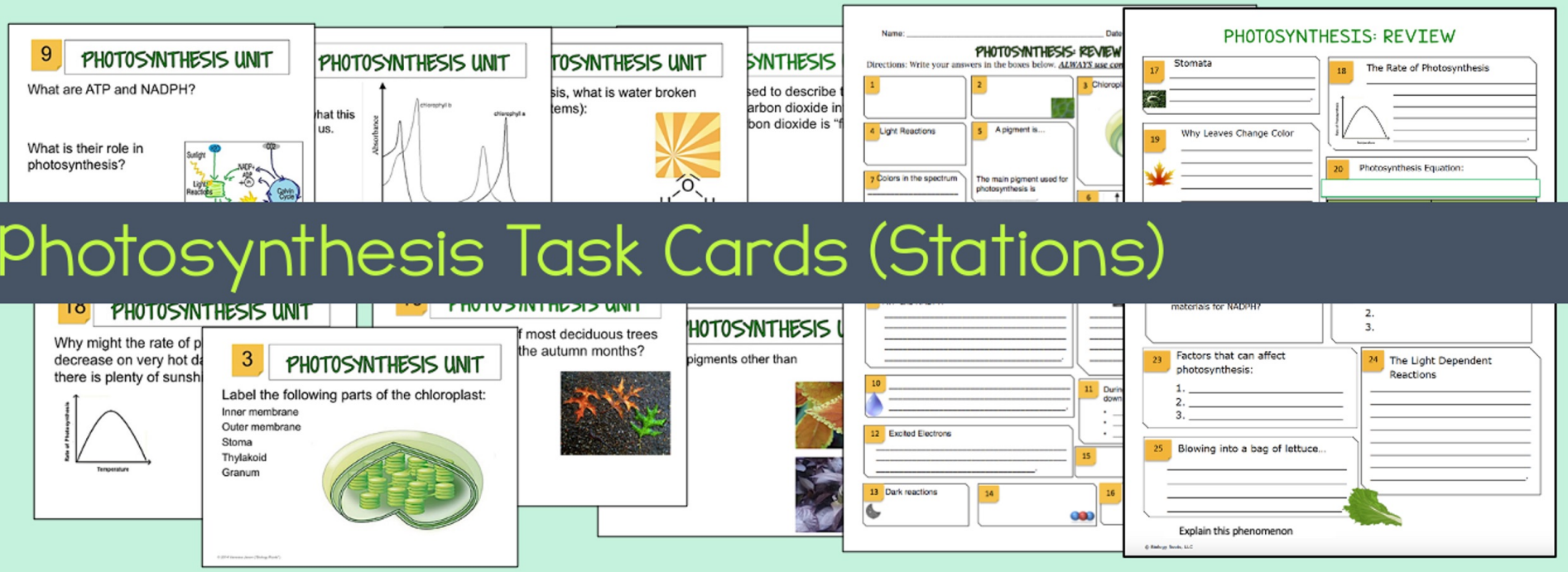
leaves green even though other pigments are present?

what you have learned in this lab, explain why leaves tend to
or in autumn in places like New England.

thesis requires the green pigment chlorophyll. Explain how a
naple tree, which has red leaves, can perform photosynthesis.

a Jason (Biology Roots)

Paper Chromatography: Pigment Powered Plants



Photosynthesis Task Cards (Stations)



Photosynthesis Review Game

PHOTOSYNTHESIS UNIT BUNDLE ~50 MINUTE BLOCKS		
DAY/DATE	STUDENT ACTIVITY AND TEACHER NOTES	LEARNING TARGET
(BEFORE)	ATLAS JOURNAL IS OPTIONAL. SEE TEACHER GUIDE IN FOLDER FOR MORE INFORMATION AND LEARNING TARGETS.	
1 _____	Photosynthesis notes up to chloroplast structure Lab: Paper Chromatography (students can answer analysis questions for homework if needed. Skip if used during ATLAS and move on to next assignment)	To outline the basic equation and importance of photosynthesis; to demonstrate pigment chromatography. Goal: students will be able to summarize the process of photosynthesis and expose pigments in leaves.
2 _____	🎨 Green Solar Cells– give students 15–20 minutes to complete before moving on to notes Photosynthesis notes: finish (open note quiz next class!) Homework: Photosynthesis Practice (if notes wrap up early have them work on in class.)	To learn about the different stages of photosynthesis and energy carriers; to label and identify parts of the chloroplast and how it relates to photosynthesis. Goal: students will determine chloroplast structure and the role it plays in photosynthesis.
3 _____	Photosynthesis open note quiz Photosynthesis and Light	To explore data regarding amount of ATP produced compared to different wavelengths of light. Goal: students will determine the relationship among light color/ intensity and ATP production.
4 _____	Review photosynthesis open note quiz; homework assignments if need be 🎨 Reactions of photosynthesis *Heads up: quiz coming up!	Students will outline the overall process of photosynthesis and compare light-dependent reactions to light-independent reactions. Goal: students will have an understanding of the relationship among light-dependent and light-independent reactions.
5 _____	Calvin Cycle Practice (work in pairs; use notes) From Sunlight to Rainbow Sugar (cut and paste) Note: lab next class	To summarize the process of photosynthesis. Goal: students will visualize how glucose is formed using the energy carriers from light reactions and depict the steps of energy flow in photosynthesis.
6 _____	🧪 Lab: The Elodea took my breath away (if you used the ATLAS version of this, you can skip this one. However, this one is more advanced and may be worth doing to tie it all together/ reinforce).	To measure how factors affect photosynthesis using carbon dioxide indicators. Goal: Students will analyze if plants can perform photosynthesis without factors such as light and CO_2.
7 _____	*Quiz: Photosynthesis OPTIONAL: Cells of the Leaf; Why Leaves Change Color (if you choose not to use these materials, move on to the next day's agenda after quiz.)	To diagram and label the cells of the leaf and relate their structure to the function of photosynthesis.

A pacing guide with learning targets is provided to guide you with lesson planning throughout the entire unit.

Includes both 50 and 90 minute blocks.

Covers both learning targets and learning goals.

Adaptable - use it as is, or make your own!

More information:

Digital versions are hosted on Google Slides.

Supports NGSS (ATLAS activities particularly).

Tests and quizzes included (not pictured).

TRULY a COMPLETE unit on photosynthesis! No need to look anywhere else! Information is thorough and presentation is engaging! Thank you!

★★★★★

-Jennifer H.

Still not sure if you need this resource?

This unit is for any teacher who is looking for a truly no-prep photosynthesis unit from start to finish, or simply a large bank of activities to use in the classroom! If your school is using an online curriculum, and you are finding that it is not consistently conducive to student learning, my unit bundles are compatible as supplemental material and really help prevent student burn out – because I know what sparks students! I also update my material to keep it modern and fresh.

Reach out with questions ☺

-Vanessa