Lesson Intention: In this lab, students will work in teams to test leaves for the production of food- or starch. They will compare a leaf that has been completely covered with black paper overnight, to one that has not. They will make the connection that green leaves change light energy into chemical energy which is then used to make food. Students should also understand that chlorophyll production is dependent on light, and without chlorophyll, food will not be produced. Students will be learning and following new lab procedures to test the leaves for presence of starch.

BY THE END OF THIS LESSON STUDENTS WILL BE ABLE TO:

- Explain how the absence of chlorophyll affects starch production in plants
- Test for starch production using a several-step procedure
- Describe why iodine is used as an indicator for starch
- Describe the process of photosynthesis, naming the components that are input and output
- Explain the reason for each procedure in the lab

Teacher Preparation:

Have several mature geranium plants available for each class.(Depending on the size, 1-2 mature plants per class. Two leaves should be available per group.) Number each plant very obviously so teams can record which plant they used.

Have black construction paper covers pre-cut, about the size of an index card- 2 per each team. Have 4-5 different colored embroidery string cut at about 10 cm lengths- 1 color per class, 2 lengths per team(for identification).

Have student instructions copied. (I make one class set. Students don't write on these, they write in their journals. That way I can recycle procedures.)

Prepare diluted tincture of iodine- 20 drops of water to each drop of tincture of iodine

Stoves, beakers, tincture of iodine, plastic wrap, safety glasses, aprons, gloves,10 ml graduated cylinders, denatured alcohol, tongs, and plastic micropipets or eyedroppers should be out and arranged for easy access.

Bellwork on board or overhead.

Materials per student: in-class journal, pencil, apron, safety goggles

Materials per team of four: one burner, 2 leaves on living plant, 2 pieces of black construction paper, 1 paper clip, a pair of tongs, two test tubes,2 test tube holders, 1 large

beaker(250 ml.), 1 graduated cylinder, 1 small bottle of diluted tincture of iodine, 1 eye dropper, water, denatured alcohol, two petri dishes

bellwork: *I have a geranium plant on my desk. Let's say I cover one leaf with a piece of cardboard, both on the top and the bottom- the leaf is in the middle of a sandwich of cardboard bread. What will happen to that leaf if I leave it like this overnight? What will happen after a few days? Why? What will happen to the rest of the plant? Remember to use descriptive words.*

Step by Step Discussion and Lab-Day 1

6. Start by asking a variety of students to read their bellwork answers aloud. Have a student write these ideas down on the board. Get students with opposing ideas to discuss their reasoning.
7. Tell students they have just made a prediction of an experiment they will be performing.
8. Hand out lab instructions. Have students open in-class journals, title and date their lab page. Students should rewrite their prediction here, along with their reasoning.
9. Read through the lab instructions with the students. Show them the materials and how they will be used. Each student should write the materials list for teams in his/her own journal. Students should set up a page for writing procedures as they perform the lab, and writing notes and observations. (I always have students rewrite their own procedures so if the results are not as expected, we can review the procedures that took place and see if a team left out a step.)
10. Each team should take one plant and cover one leaf with the 2 pieces of construction paper as instructed. They should also choose another leaf around the same size and location. They should tie a colored string around each leaf to identify the leaves the following day.

Step by step cont. -Day 2

Bellwork: *Why are aprons, tongs, and safety glasses necessary for today's lab?*

11. Start by discussing bellwork. Give any last minute clarifications or instructions. Remind students of precautions.Remind them that you will be looking to see if they are wearing goggles, and aprons at all times.
12. Give instructions for picking up/ handing out materials.
13. Students carry out lab until they have two bleached leaves and have tested each leaf for starch. If they don't have time. They can keep the leaves in water overnight and perform the starch test the following day.
14. After students have finished the lab, and had time to write down the procedures, observations and results, follow up with a lecture/discussion/video or laser disk on what occurred and why.(Day 3)

Viewing Leaf Stomata

Lesson 8 ✌_

Day 10

Lesson Intention: Eighth grade students really don't understand yet that leaves breathe, or respire. They know that plants give off oxygen but they're not sure how. They also don't know that plants also *take in* oxygen through respiration at night(or in the dark) and release carbon dioxide. This lesson will introduce students to the stomata structures that allow this to occur.

BY THE END OF THIS LESSON STUDENTS WILL BE ABLE TO:

- Recognize stomata under the microscope
- Describe the form and function of stomata
- Explain how the stomata fit into the process of photosynthesis

Materials per student: in-class journals, pencil

Materials per team: geranium leaf, microscope, slide, cover slip, water, tweezers

Teacher Preparation:

Students will use the geranium plants from the previous experiment. Make sure there are enough leaves left for each 2 teams to share 1 leaf (per class).

Set out microscopes, slides, cover slips, and tweezers, one per team.

Connect stereoscope to computer and student-viewing monitor if available.

Prepare a slide ahead of time and view making sure you can see the stomata, guard cells and epidermal cells.

Bellwork on board or overhead.

Bellwork: *We've talked about leaves taking carbon dioxide and water and converting them using sunlight and chlorophyll into oxygen and sugar. How does the leaf get the carbon dioxide? How does it give of oxygen? What kind of structures might leaves have to allow them to "breathe?" Draw a leaf, what the structure might look like and where it will be found.*

Step by Step Discussion and Lab

Begin by asking 4 students to draw their ideas on different areas of the board at the same time. Have each student explain his/her diagram/ideas.

Explain to the students that they will be viewing and drawing those structures that allow the plant to respire.

Teach by showing the students the technique to view those structure.

Pick a fresh geranium leaf from a plant.

Turn the leaf so the lower side is up.

Using tweezers, tear a small section of a thin layer of tissue from the underside of the leaf.

Carefully lay the tissue in a drop of water on the slide.

Add a cover slip and view through the low power of the microscope.

6. Point out the stomata, guard cells, and epidermal cells on the monitor, from the slide you have already prepared.
7. Students are requires to view and draw the stomata they find. Label the stomata, guard cells and epidermal cells. Each student in the team should take about 5 minutes each to view the slide. Each team should find the average number of stomata on their section of tissue by counting stomata then moving the slide until new stomata come into view. Each student in the team can do this, get a count, then the team can average the four numbers.
8. Give instructions for gathering materials. Teams begin to prepare and view slides.

EXTENSION: Students can come up with hypotheses about different types of leaves versus number of stomata. They can test their hypotheses by designing a performing a similar experiment.

Form and Function- Plant water and gas exchange

A jigsaw reading activity

Lesson 9

Days 11 & 12

Lesson Intention: In this lesson each student on team will be responsible for reading and understanding a certain section of material. For the first part of this lesson students will form reading groups based on the section of reading they are assigned. During the second part, students will come back to their original teams to teach each other about what they learned, and to design a flow chart/poster that incorporates all the parts of the reading. Students will be expected to think about a plant as a functioning factory- with inputs and outputs, and a particular flow of procedures. In their poster they will be expected to visually represent sunlight, gases, water and minerals, and show how different plant parts deal with these materials to make food and grow.

BY THE END OF THIS LESSON STUDENTS WILL BE ABLE TO:

- Explain the function of the leaves in making food
- Explain the function of osmosis in the transpiration stream of a plant
- Diagram a vascular bundle, labeling the xylem, phloem, cambium, showing the movement of food out of the leaf through the phloem and movement of water into the leaf through the xylem
- Explain the role of sap in plants
- Describe the function and location of stomata, chloroplast, chlorophyll, palisade cells, guard cells, epidermis and mesophyll.

Materials per student: in-class journal, pencil, 1 copy of *What are Plants made of ?* and 1 copy of either *Inside a leaf*; *Stomata- the inside story*; *Making food*; or *Plant Plumbing*

Materials per team: Large piece of butcher paper; markers, colored pencils, etc.; flow chart/poster rubric

Teacher Preparation:

6. Make a class set of the reading: *What are plants made of?* and the flow chart/poster rubric
7. Make 8 copies each of: *Inside a leaf*;

   Stomata- the inside story;

   Making food;

   Plant Plumbing 30 students)≅(based on

8. Cut enough butcher paper for each team of each class
9. Have art materials out or available to the teams
10. Bellwork on board or overhead.

Bellwork: *Yesterday you viewed a leaf structure which looks like a pore. In silence and without looking at your notes, draw and label this structure and the cells that are next to it. Where is it found on the leaf? What is its function? THIS IS A QUIZ!*

Step by Step Lesson

1. After 3-5 minutes start walking around tables, from student to student and immediately grade quizzes. A quick 3 points! (I don't talk, I just mark from 0-3 and go on to the next student. Fast!)

- After grading the Bellwork quiz, have a student who did well go to the board and draw the correct response. Discuss and answer any questions.
- Explain to the students that they will be doing a "jigsaw" reading. That means that each group member will be responsible for one part of the material, and for teaching it to the rest of the team. The instructions are as follows:

  - All the students with the same reading will be part of a reading group. After 20 minutes of reading, study, discussion and note-taking they will come back to their groups as an "expert" in that one field. The readings will be collected after 20 minutes. They must be able to rely on your notes!

  -Back at the teams, each member will share his or her knowledge with the rest of the group. His/Her group members should be expected to ask questions. The "expert" should be able to answer. Each team member shares his/her knowledge.

  -When all members have shared their knowledge and notes, the team will all raise their hand to get the attention of the teacher. She will review their material and provide them with the next task.

- When the instructions have been explained, hand out the readings to the students. Direct them to different areas of the room so those that have the same reading can read and discuss together.
- When students are settled in each of the 4 areas, have them read silently for the first 7 minutes. This gives them some time to focus and look at the diagrams.
- While students are working, walk around and clarify and problems the students are having with the readings.
- After 20 minutes, ***collect the readings*** and have the students go back to their teams.(I limit student to student independent work time because eighth graders tend to socialize anytime they have the chance!) Remind them of their next task. This should take you through to the end of Day 1.

Day 2

Bellwork: *Discuss with your team how much time you need and who still needs to share their knowledge and notes. Make a plan and tell me at what time you will be ready for the next phase of the assignment. Raise your hand when your team has agreed on the plan.*

- Give students needed time to finish pooling their knowledge and notes.
- When team members collectively raise their hands, give them the next phase of the assignment which includes the rubric. Make sure the team understands and they begin to make posters.
- Students should use the rest of the class to complete their posters. (If students want to finish at home, I don't allow it. They need to learn to work together at a consistent pace and to use class time wisely. If the whole class seems to need more time, I will allot it, but not to individual teams.)

Plants, Photosynthesis, and Respiration

Lesson 10

Days 13 & 14

Lesson Intention: This lesson, designed as a teacher demonstration, is visual proof that like humans, plants also respire. By using bromthymol blue solution as an indicator for the presence of carbon dioxide, students will compare plants photosynthesizing in the presence of more and less CO_2. They see quite vividly how the indicator changes color in the presence of carbon dioxide, and returns to its original blue as CO_2 is used in photosynthesis. This demonstration also shows students a way to test for the presence of oxygen, and is also a review of variables, controls and the process of photosynthesis. The plant used is elodea. When viewed under a microscope, its moving chloroplasts are easily seen because the leaves are only two cells thick.

BY THE END OF THIS LESSON STUDENTS WILL BE ABLE TO:

- Explain what a color change indicates with bromthymol blue
- Answer the question: Is the rate of photosynthesis affected by the amount of CO_2 available to a plant?
- Provide evidence that photosynthesis and respiration have occurred
- Make correct predictions about when the color change will occur
- Define what occurs during plant respiration

Materials per student: in class journals, pencil

Materials:(listed on **Teacher Notes** page)

Teacher Preparation:

6. Acquire several sprigs of elodea (also called *anacharis*), a water plant which can be easily found at stores that sell fish and fish tank supplies.
7. Read through the **Teacher Notes** page for this Lesson. Set up the two experiments as explained.
8. Have four test tubes of bromthymol blue solution available for each class to demonstrate that when students exhale CO_2 a color change occurs to the bromthymol blue solution. Several straws per class are also necessary.
9. Bellwork on board or overhead.

Bellwork : *As you see, I have a funnel with elodea plants(water plants) placed upside down in a beaker of water. There is a test tube upside down over the opening of the funnel. This has been in the light for several hours. From your knowledge of photosynthesis, what is gathering in the tip of the test tube. Come look closely. What is your evidence?*

Step by Step Discussion and Demonstration

1. Ask for student volunteers to read responses to the Bellwork. Students may suggest that a gas is being let off due to the bubbles they see. They may think it is oxygen or carbon dioxide. When confusion about which gas it is arises, review the process of photosynthesis, and the difference between photosynthesis and respiration.
2. Tell the students that there is a test that can be done to tell whether the gas is oxygen or carbon dioxide called the splint test. Ask students what they know about what fire needs to continue burning. Hopefully the response will be "oxygen." Explain that if a wood splint is burned then extinguished, if it is put in contact with oxygen in a test tube, it will relight. If there is CO_2 in the test tube it will not. It can be explained further that CO2 is actually used to extinguish fire. (A quick demonstration of this is to light a candle, make a mixture of 2 Tbsp.baking soda and 10ml vinegar in a beaker, pour the CO_2 gas-NOT the solution!- that has been created, down a paper towel tube that is held over the flame and the light will extinguish.)
3. Take the test tube carefully out of the beaker by lifting it directly up, keeping it upside down. Put a stopper on the test tube.
4. Light a splint of wood (popsicle stick split in half length-wise), then have a student blow it out.

5. Hand the test tube to another student and have her uncork it. Put the hot splint quickly into the tube. It should relight. Take the splint out, extinguish it and cork the test tube again. There may be enough oxygen to relight the splint again.
6. Now it is established that the gas produced is oxygen. Photosynthesis has been taking place. Ask a student to review the events and the reasons for the splint test. What was the evidence that photosynthesis occurred? How do we know it wasn't CO_2 in the tube?
7. Introduce the four numbered test tubes with bromthymol blue solution. Explain that bromthymol blue is used as an indicator also, like the splint test, it is a test for the presense of a gas.
8. Invite a student to come and gently blow air , using a straw, into test tube #1. Ask the students to guess what may happen before he/she does. Take predictions. Have the student begin to blow and continue to blow until the color has completely changed. Ask: "Why did the bromthymol blue change color? What gas is it a test for?"
9. To convince students of this phenomena, ask another student volunteer to blow air gently into test tube #2. It too changes color and should be completely yellow before they stop.
10. Ask the students what gas as been added to test tubes 1 & 2. Then tell the students that test tubes 3 & 4 will remain blue, indicating no dissolved CO_2. Then ask the students to get their in class journals out to make a written prediction.
11. Show the students the 4 sprigs of elodea. As you are putting one sprig in each test tube, and putting a cork in each tube, review the contents of the containers. Numbers 1 & 2 have dissolved CO_2 and plenty of it, while tubes # 3 & 4 don't. Tell as you show that each tube will sit in a container of water near a bright light source. Students answer the following in their journals:

    Based on your knowledge of photosynthesis and respiration, what changes do you expect to occur to each tube? What color will each tube be tomorrow and why? What do the changes in each tube indicate?

What is the purpose of each of the tubes in the experiment?

12. After approx. 5 minutes have a variety of students share their predictions. Make a tally sheet on the board or sheet of paper of how many students think change will occur in the different tubes.

Day 2

Bellwork: *Reread your predictions from yesterday's demonstration about what you expected to happen to the four test tubes. Get ready to see the results and write them down.*

13. Begin by showing the students one test tube at a time. Ask what they thought would happen and why, then show the tube. Talk about if the predictions were correct and clear up any misconceptions. When discussing tubes number 2 & 4, talk about the necessity for controls in experiments. When discussing numbers 1 & 3 discuss variables.
14. After students have a firm grasp on gases and photosynthesis, ask the students to make another prediction about the same setup that instead of put under light, was put in the dark.
15. Set up the experiment in the same way as the day before. Put the tubes in a box and seal the box.

Teacher Notes

Plants, Photosynthesis, and Respiration

Lesson 10

Photosynthesis

- In the presence of light, plants combine CO_2 and water to form food(chemical energy) and oxygen.
- Oxygen is a by-product of photosynthesis
- Chloroplasts in green plants, which contain chlorophyll, capture the energy from the light and help covert it to food.
- Chlorophyll is considered a catalyst- it helps chemical reactions to take place but remains unchanged itself
- Food, in the form of glucose (sugar), can be used as energy or stored as carbohydrates
- Stored food is starch which is a large chain of sugars

Respiration

- The process in which all living cells obtain energy from stored food
- Food is oxidized, or combined with oxygen in a series of chemical reactions and as a result, energy is released and water and CO_2 are produced as waste products.
- Respiration in plants occurs at night and day,and is the only ways plants break down glucose.

Demonstration #1- Photosynthesis and the production of oxygen

Materials: 1 beaker nearly filled with room temperature water; several healthy sprigs of elodea plant; clear funnel that can fit, upside down, in the beaker;

ONLY ONE OF THESE IS NEEDED FOR ALL CLASSES

Set up:

1. Cut the end of the elodea with a clean, fresh razor blade.

2. Place the elodea in the beaker
3. Cover the elodea with a funnel whose tip is below the water level in the beaker
4. Make sure the cut ends of the elodea point upward toward the neck of the funnel.
5. Fill a test tube with water, cork it with your thumb, and lower it, upside down, over the stem of the funnel. See diagram 1.

Demonstration #2- Plants and CO_2

Materials per class: 4 test tubes, masking tape, bromthymol blue solution(Follow manufacturers preperation suggestions then test), elodea sprigs, beakers with water, grow light or window, 2 straws

Set up:

6. Place a small piece of masking tape on each tube and mark them 1-4 with a permanent ink marker.
7. Fill all test tubes approx. half way with water.
8. Add 1.0 ml of bromthymol blue to each test tube. See diagram 2
9. After students blow CO_2 into tubes 1 & 2, place sprigs of elodea into tubes 1 & 3, then seal all test tubes with stoppers.

Elodea/Anacharis- a common water plant that can be found at aquarium or tropical fish stores. It is usually used to furnish oxygen to fish in tanks.

Bromthymol blue- is an acid/base indicator. It is blue in a base, such as ammonia, and yellow in acid, such as vinegar. When carbon dioxide is dissolved in water it forms carbonic acid, therefore turning bromthymol blue, yellow. Color change is continuous, with low CO_2 resulting in a blue-green solution, more CO_2 turns greenish yellow while a saturation of CO_2 goes yellow.

Photosynthesis-Leaves Make the Food

Lesson 6 _🕙✌

Lesson 7☺_

Days 7,8 & 9

Lesson Intention: In this lab, students will work in teams to test leaves for the production of food- or starch. They will compare a leaf that has been completely covered with black paper overnight, to one that has not. They will make the connection that green leaves change light energy into chemical energy which is then used to make food. Students should also understand that chlorophyll production is dependent on light, and without chlorophyll, food will not be produced. Students will be learning and following new lab procedures to test the leaves for presence of starch.

BY THE END OF THIS LESSON STUDENTS WILL BE ABLE TO:

- Explain how the absence of chlorophyll affects starch production in plants
- Test for starch production using a several-step procedure
- Describe why iodine is used as an indicator for starch
- Describe the process of photosynthesis, naming the components that are input and output
- Explain the reason for each procedure in the lab

Teacher Preparation:

Have several mature geranium plants available for each class.(Depending on the size, 1-2 mature plants per class. Two leaves should be available per group.) Number each plant very obviously so teams can record which plant they used.

Have black construction paper covers pre-cut, about the size of an index card- 2 per each team. Have 4-5 different colored embroidery string cut at about 10 cm lengths- 1 color per class, 2 lengths per team(for identification).

Have student instructions copied. (I make one class set. Students don't write on these, they write in their journals. That way I can recycle procedures.)

Prepare diluted tincture of iodine- 20 drops of water to each drop of tincture of iodine

Stoves, beakers, tincture of iodine, plastic wrap, safety glasses, aprons, gloves,10 ml graduated cylinders, denatured alcohol, tongs, and plastic micropipets or eyedroppers should be out and arranged for easy access.

Bellwork on board or overhead.

Materials per student: in-class journal, pencil, apron, safety goggles

Materials per team of four: one burner, 2 leaves on living plant, 2 pieces of black construction paper, 1 paper clip, a pair of tongs, two test tubes,2 test tube holders, 1 large

beaker(250 ml.), 1 graduated cylinder, 1 small bottle of diluted tincture of iodine, 1 eye dropper, water, denatured alcohol, two petri dishes

bellwork: *I have a geranium plant on my desk. Let's say I cover one leaf with a piece of cardboard, both on the top and the bottom- the leaf is in the middle of a sandwich of cardboard bread. What will happen to that leaf if I leave it like this overnight? What will happen after a few days? Why? What will happen to the rest of the plant? Remember to use descriptive words.*

Step by Step Discussion and Lab-Day 1

6. Start by asking a variety of students to read their bellwork answers aloud. Have a student write these ideas down on the board. Get students with opposing ideas to discuss their reasoning.
7. Tell students they have just made a prediction of an experiment they will be performing.
8. Hand out lab instructions. Have students open in-class journals, title and date their lab page. Students should rewrite their prediction here, along with their reasoning.
9. Read through the lab instructions with the students. Show them the materials and how they will be used. Each student should write the materials list for teams in his/her own journal. Students should set up a page for writing procedures as they perform the lab, and writing notes and observations. (I always have students rewrite their own procedures so if the results are not as expected, we can review the procedures that took place and see if a team left out a step.)
10. Each team should take one plant and cover one leaf with the 2 pieces of construction paper as instructed. They should also choose another leaf around the same size and location. They should tie a colored string around each leaf to identify the leaves the following day.

Step by step cont. -Day 2

Bellwork: *Why are aprons, tongs, and safety glasses necessary for today's lab?*

11. Start by discussing bellwork. Give any last minute clarifications or instructions. Remind students of precautions.Remind them that you will be looking to see if they are wearing goggles, and aprons at all times.
12. Give instructions for picking up/ handing out materials.
13. Students carry out lab until they have two bleached leaves and have tested each leaf for starch. If they don't have time. They can keep the leaves in water overnight and perform the starch test the following day.
14. After students have finished the lab, and had time to write down the procedures, observations and results, follow up with a lecture/discussion/video or laser disk on what occurred and why.(Day 3)

Viewing Leaf Stomata

Lesson 8 ✌_

Day 10

Lesson Intention: Eighth grade students really don't understand yet that leaves breathe, or respire. They know that plants give off oxygen but they're not sure how. They also don't know that plants also *take in* oxygen through respiration at night(or in the dark) and release carbon dioxide. This lesson will introduce students to the stomata structures that allow this to occur.

BY THE END OF THIS LESSON STUDENTS WILL BE ABLE TO:

- Recognize stomata under the microscope
- Describe the form and function of stomata
- Explain how the stomata fit into the process of photosynthesis

Materials per student: in-class journals, pencil

Materials per team: geranium leaf, microscope, slide, cover slip, water, tweezers

Teacher Preparation:

Students will use the geranium plants from the previous experiment. Make sure there are enough leaves left for each 2 teams to share 1 leaf (per class).

Set out microscopes, slides, cover slips, and tweezers, one per team.

Connect stereoscope to computer and student-viewing monitor if available.

Prepare a slide ahead of time and view making sure you can see the stomata, guard cells and epidermal cells.

Bellwork on board or overhead.

Bellwork: *We've talked about leaves taking carbon dioxide and water and converting them using sunlight and chlorophyll into oxygen and sugar. How does the leaf get the carbon dioxide? How does it give of oxygen? What kind of structures might leaves have to allow them to "breathe?" Draw a leaf, what the structure might look like and where it will be found.*

Step by Step Discussion and Lab

Begin by asking 4 students to draw their ideas on different areas of the board at the same time. Have each student explain his/her diagram/ideas.

Explain to the students that they will be viewing and drawing those structures that allow the plant to respire.

Teach by showing the students the technique to view those structure.

Pick a fresh geranium leaf from a plant.

Turn the leaf so the lower side is up.

Using tweezers, tear a small section of a thin layer of tissue from the underside of the leaf.

Carefully lay the tissue in a drop of water on the slide.

Add a cover slip and view through the low power of the microscope.

6. Point out the stomata, guard cells, and epidermal cells on the monitor, from the slide you have already prepared.
7. Students are requires to view and draw the stomata they find. Label the stomata, guard cells and epidermal cells. Each student in the team should take about 5 minutes each to view the slide. Each team should find the average number of stomata on their section of tissue by counting stomata then moving the slide until new stomata come into view. Each student in the team can do this, get a count, then the team can average the four numbers.
8. Give instructions for gathering materials. Teams begin to prepare and view slides.

EXTENSION: Students can come up with hypotheses about different types of leaves versus number of stomata. They can test their hypotheses by designing a performing a similar experiment.

Form and Function- Plant water and gas exchange

A jigsaw reading activity

Lesson 9

Days 11 & 12

Lesson Intention: In this lesson each student on team will be responsible for reading and understanding a certain section of material. For the first part of this lesson students will form reading groups based on the section of reading they are assigned. During the second part, students will come back to their original teams to teach each other about what they learned, and to design a flow chart/poster that incorporates all the parts of the reading. Students will be expected to think about a plant as a functioning factory- with inputs and outputs, and a particular flow of procedures. In their poster they will be expected to visually represent sunlight, gases, water and minerals, and show how different plant parts deal with these materials to make food and grow.

BY THE END OF THIS LESSON STUDENTS WILL BE ABLE TO:

- Explain the function of the leaves in making food
- Explain the function of osmosis in the transpiration stream of a plant
- Diagram a vascular bundle, labeling the xylem, phloem, cambium, showing the movement of food out of the leaf through the phloem and movement of water into the leaf through the xylem
- Explain the role of sap in plants
- Describe the function and location of stomata, chloroplast, chlorophyll, palisade cells, guard cells, epidermis and mesophyll.

Materials per student: in-class journal, pencil, 1 copy of *What are Plants made of ?* and 1 copy of either *Inside a leaf*; *Stomata- the inside story*; *Making food*; or *Plant Plumbing*

Materials per team: Large piece of butcher paper; markers, colored pencils, etc.; flow chart/poster rubric

Teacher Preparation:

6. Make a class set of the reading: *What are plants made of?* and the flow chart/poster rubric
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   Stomata- the inside story;

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8. Cut enough butcher paper for each team of each class
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Bellwork: *Yesterday you viewed a leaf structure which looks like a pore. In silence and without looking at your notes, draw and label this structure and the cells that are next to it. Where is it found on the leaf? What is its function? THIS IS A QUIZ!*

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1. After 3-5 minutes start walking around tables, from student to student and immediately grade quizzes. A quick 3 points! (I don't talk, I just mark from 0-3 and go on to the next student. Fast!)

- After grading the Bellwork quiz, have a student who did well go to the board and draw the correct response. Discuss and answer any questions.
- Explain to the students that they will be doing a "jigsaw" reading. That means that each group member will be responsible for one part of the material, and for teaching it to the rest of the team. The instructions are as follows:

  - All the students with the same reading will be part of a reading group. After 20 minutes of reading, study, discussion and note-taking they will come back to their groups as an "expert" in that one field. The readings will be collected after 20 minutes. They must be able to rely on your notes!

  -Back at the teams, each member will share his or her knowledge with the rest of the group. His/Her group members should be expected to ask questions. The "expert" should be able to answer. Each team member shares his/her knowledge.

  -When all members have shared their knowledge and notes, the team will all raise their hand to get the attention of the teacher. She will review their material and provide them with the next task.

- When the instructions have been explained, hand out the readings to the students. Direct them to different areas of the room so those that have the same reading can read and discuss together.
- When students are settled in each of the 4 areas, have them read silently for the first 7 minutes. This gives them some time to focus and look at the diagrams.
- While students are working, walk around and clarify and problems the students are having with the readings.
- After 20 minutes, ***collect the readings*** and have the students go back to their teams.(I limit student to student independent work time because eighth graders tend to socialize anytime they have the chance!) Remind them of their next task. This should take you through to the end of Day 1.

Day 2

Bellwork: *Discuss with your team how much time you need and who still needs to share their knowledge and notes. Make a plan and tell me at what time you will be ready for the next phase of the assignment. Raise your hand when your team has agreed on the plan.*

- Give students needed time to finish pooling their knowledge and notes.
- When team members collectively raise their hands, give them the next phase of the assignment which includes the rubric. Make sure the team understands and they begin to make posters.
- Students should use the rest of the class to complete their posters. (If students want to finish at home, I don't allow it. They need to learn to work together at a consistent pace and to use class time wisely. If the whole class seems to need more time, I will allot it, but not to individual teams.)

Plants, Photosynthesis, and Respiration

Lesson 10

Days 13 & 14

Lesson Intention: This lesson, designed as a teacher demonstration, is visual proof that like humans, plants also respire. By using bromthymol blue solution as an indicator for the presence of carbon dioxide, students will compare plants photosynthesizing in the presence of more and less CO_2. They see quite vividly how the indicator changes color in the presence of carbon dioxide, and returns to its original blue as CO_2 is used in photosynthesis. This demonstration also shows students a way to test for the presence of oxygen, and is also a review of variables, controls and the process of photosynthesis. The plant used is elodea. When viewed under a microscope, its moving chloroplasts are easily seen because the leaves are only two cells thick.

BY THE END OF THIS LESSON STUDENTS WILL BE ABLE TO:

- Explain what a color change indicates with bromthymol blue
- Answer the question: Is the rate of photosynthesis affected by the amount of CO_2 available to a plant?
- Provide evidence that photosynthesis and respiration have occurred
- Make correct predictions about when the color change will occur
- Define what occurs during plant respiration

Materials per student: in class journals, pencil

Materials:(listed on **Teacher Notes** page)

Teacher Preparation:

6. Acquire several sprigs of elodea (also called *anacharis*), a water plant which can be easily found at stores that sell fish and fish tank supplies.
7. Read through the **Teacher Notes** page for this Lesson. Set up the two experiments as explained.
8. Have four test tubes of bromthymol blue solution available for each class to demonstrate that when students exhale CO_2 a color change occurs to the bromthymol blue solution. Several straws per class are also necessary.
9. Bellwork on board or overhead.

Bellwork : *As you see, I have a funnel with elodea plants(water plants) placed upside down in a beaker of water. There is a test tube upside down over the opening of the funnel. This has been in the light for several hours. From your knowledge of photosynthesis, what is gathering in the tip of the test tube. Come look closely. What is your evidence?*

Step by Step Discussion and Demonstration

1. Ask for student volunteers to read responses to the Bellwork. Students may suggest that a gas is being let off due to the bubbles they see. They may think it is oxygen or carbon dioxide. When confusion about which gas it is arises, review the process of photosynthesis, and the difference between photosynthesis and respiration.
2. Tell the students that there is a test that can be done to tell whether the gas is oxygen or carbon dioxide called the splint test. Ask students what they know about what fire needs to continue burning. Hopefully the response will be "oxygen." Explain that if a wood splint is burned then extinguished, if it is put in contact with oxygen in a test tube, it will relight. If there is CO_2 in the test tube it will not. It can be explained further that CO2 is actually used to extinguish fire. (A quick demonstration of this is to light a candle, make a mixture of 2 Tbsp.baking soda and 10ml vinegar in a beaker, pour the CO_2 gas-NOT the solution!- that has been created, down a paper towel tube that is held over the flame and the light will extinguish.)
3. Take the test tube carefully out of the beaker by lifting it directly up, keeping it upside down. Put a stopper on the test tube.
4. Light a splint of wood (popsicle stick split in half length-wise), then have a student blow it out.

5. Hand the test tube to another student and have her uncork it. Put the hot splint quickly into the tube. It should relight. Take the splint out, extinguish it and cork the test tube again. There may be enough oxygen to relight the splint again.
6. Now it is established that the gas produced is oxygen. Photosynthesis has been taking place. Ask a student to review the events and the reasons for the splint test. What was the evidence that photosynthesis occurred? How do we know it wasn't CO_2 in the tube?
7. Introduce the four numbered test tubes with bromthymol blue solution. Explain that bromthymol blue is used as an indicator also, like the splint test, it is a test for the presense of a gas.
8. Invite a student to come and gently blow air , using a straw, into test tube #1. Ask the students to guess what may happen before he/she does. Take predictions. Have the student begin to blow and continue to blow until the color has completely changed. Ask: "Why did the bromthymol blue change color? What gas is it a test for?"
9. To convince students of this phenomena, ask another student volunteer to blow air gently into test tube #2. It too changes color and should be completely yellow before they stop.
10. Ask the students what gas as been added to test tubes 1 & 2. Then tell the students that test tubes 3 & 4 will remain blue, indicating no dissolved CO_2. Then ask the students to get their in class journals out to make a written prediction.
11. Show the students the 4 sprigs of elodea. As you are putting one sprig in each test tube, and putting a cork in each tube, review the contents of the containers. Numbers 1 & 2 have dissolved CO_2 and plenty of it, while tubes # 3 & 4 don't. Tell as you show that each tube will sit in a container of water near a bright light source. Students answer the following in their journals:

    Based on your knowledge of photosynthesis and respiration, what changes do you expect to occur to each tube? What color will each tube be tomorrow and why? What do the changes in each tube indicate?

What is the purpose of each of the tubes in the experiment?

12. After approx. 5 minutes have a variety of students share their predictions. Make a tally sheet on the board or sheet of paper of how many students think change will occur in the different tubes.

Day 2

Bellwork: *Reread your predictions from yesterday's demonstration about what you expected to happen to the four test tubes. Get ready to see the results and write them down.*

13. Begin by showing the students one test tube at a time. Ask what they thought would happen and why, then show the tube. Talk about if the predictions were correct and clear up any misconceptions. When discussing tubes number 2 & 4, talk about the necessity for controls in experiments. When discussing numbers 1 & 3 discuss variables.
14. After students have a firm grasp on gases and photosynthesis, ask the students to make another prediction about the same setup that instead of put under light, was put in the dark.
15. Set up the experiment in the same way as the day before. Put the tubes in a box and seal the box.

Teacher Notes

Plants, Photosynthesis, and Respiration

Lesson 10

Photosynthesis

- In the presence of light, plants combine CO_2 and water to form food(chemical energy) and oxygen.
- Oxygen is a by-product of photosynthesis
- Chloroplasts in green plants, which contain chlorophyll, capture the energy from the light and help covert it to food.
- Chlorophyll is considered a catalyst- it helps chemical reactions to take place but remains unchanged itself
- Food, in the form of glucose (sugar), can be used as energy or stored as carbohydrates
- Stored food is starch which is a large chain of sugars

Respiration

- The process in which all living cells obtain energy from stored food
- Food is oxidized, or combined with oxygen in a series of chemical reactions and as a result, energy is released and water and CO_2 are produced as waste products.
- Respiration in plants occurs at night and day,and is the only ways plants break down glucose.

Demonstration #1- Photosynthesis and the production of oxygen

Materials: 1 beaker nearly filled with room temperature water; several healthy sprigs of elodea plant; clear funnel that can fit, upside down, in the beaker;

ONLY ONE OF THESE IS NEEDED FOR ALL CLASSES

Set up:

1. Cut the end of the elodea with a clean, fresh razor blade.

2. Place the elodea in the beaker
3. Cover the elodea with a funnel whose tip is below the water level in the beaker
4. Make sure the cut ends of the elodea point upward toward the neck of the funnel.
5. Fill a test tube with water, cork it with your thumb, and lower it, upside down, over the stem of the funnel. See diagram 1.

Demonstration #2- Plants and CO_2

Materials per class: 4 test tubes, masking tape, bromthymol blue solution(Follow manufacturers preperation suggestions then test), elodea sprigs, beakers with water, grow light or window, 2 straws

Set up:

6. Place a small piece of masking tape on each tube and mark them 1-4 with a permanent ink marker.
7. Fill all test tubes approx. half way with water.
8. Add 1.0 ml of bromthymol blue to each test tube. See diagram 2
9. After students blow CO_2 into tubes 1 & 2, place sprigs of elodea into tubes 1 & 3, then seal all test tubes with stoppers.

Elodea/Anacharis- a common water plant that can be found at aquarium or tropical fish stores. It is usually used to furnish oxygen to fish in tanks.

Bromthymol blue- is an acid/base indicator. It is blue in a base, such as ammonia, and yellow in acid, such as vinegar. When carbon dioxide is dissolved in water it forms carbonic acid, therefore turning bromthymol blue, yellow. Color change is continuous, with low CO_2 resulting in a blue-green solution, more CO_2 turns greenish yellow while a saturation of CO_2 goes yellow.

Flowers: Form, Function and Sexual Reproduction

Bees and Bats as Pollinators

Coevolution of Plants and their Pollinators