**Lesson 3 Subject and Topic:** Introduction to Respiration and Photosynthesis

**Grade Level(s):** 6-8

**Brief Description of Lesson:** Participants will be introduced to the concepts of cellular respiration. They will also continue to make observations for the mini greenhouses to collect data about the impact of light in the growth of plants

# STAGE 1: IDENTIFY DESIRED RESULTS

- **Enduring Understanding(s):**
    - Humans and animals produce carbon dioxide through the process of cellular respiration.
    - Every living thing is composed in its majority of carbon, nitrogen, oxygen and hydrogen.
    - All organisms produce Adenosine Triphosphate (ATP), a molecule that stores all the energy that comes from foods.
    - Photosynthesis is the process of converting light energy to chemical energy and storing it in the bonds of sugar. Plants only need light energy, $CO_2$, and $H_2O$ to make sugar.
    - Chlorophyll is essential for photosynthesis.

- **Essential question(s):**
    - What do living things produce through cellular respiration?
    - What are the four elements that every living thing is composed of?
    - What is ATP?
    - What is photosynthesis?

- **Standards**

- Next Generation Science Standards

    - MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
    - MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
    - MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

- Common Core State Standards

    - CCSS.Math.Content.6.SP.B.5b Summarize numerical data sets in relation to their context, such as by describing the nature of the attribute under investigation, including how it was measured and its units of measurement.

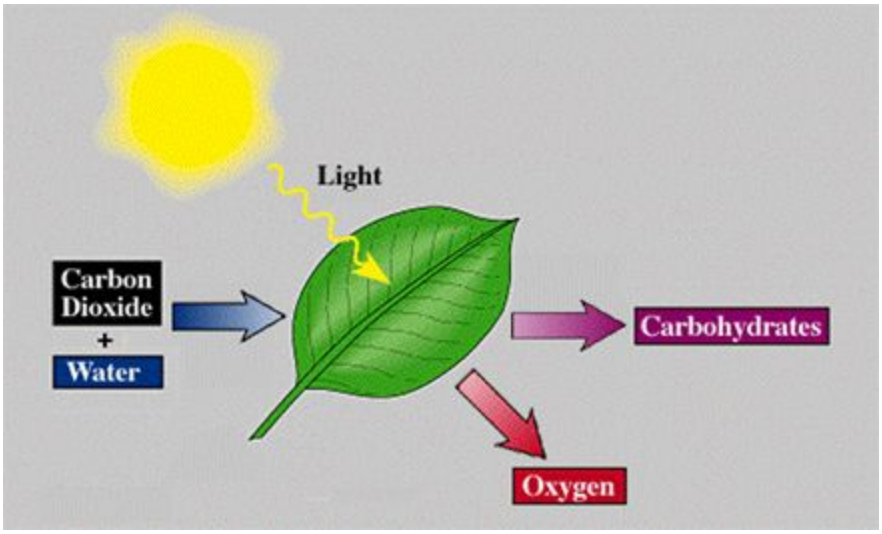
- **CCSS Standard for Mathematical Practice:**

- CCSS.Math.Practice.MP2 Reason abstractly and quantitatively.

- **Key Content Knowledge and Skills**

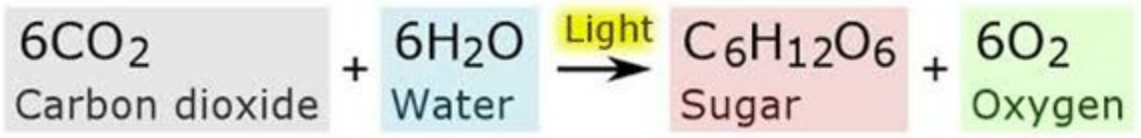
Students will know:

- Photosynthesis is the process of converting light energy from the sun into chemical energies of sugar molecules and other organic compounds.

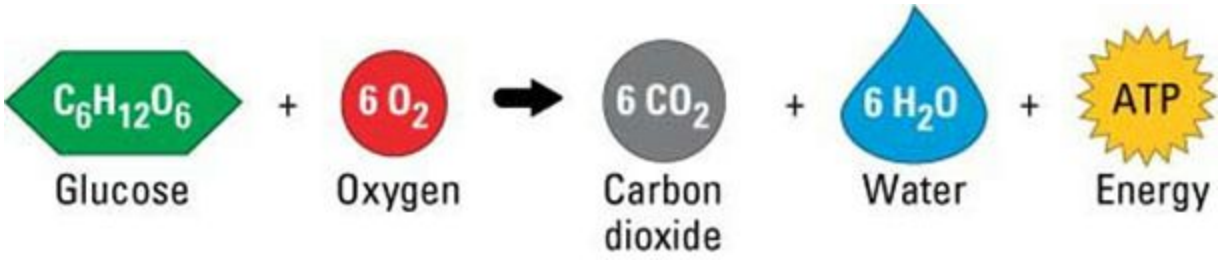



- The chemical reaction primarily takes place in the leaves of the plants and into the chloroplast. To store the chemical energy and form the sugar molecule, the chemical reaction requires carbon dioxide ($CO_2$) and water ($H_2O$). Light energy from light drives the reactions. The oxygen ($O_2$) partially releases into the atmosphere, so humans can breathe it in. The following equation summarizes photosynthesis:

$$CO_2 + 6\ H_2O \rightarrow 6(CH_2O) + 6\ O_2$$




- Human's breath in the Oxygen released from the plants.
- Respiration is the opposite of photosynthesis and it is a process in which a cell uses Oxygen to "burn" molecules and release energy.
- Cellular Respiration is the process in which the chemical energy of molecules from "food" is released and partially stored in the molecular cellular form of Adenosine Triphosphate (ATP) which stores the energy humans' use to make just about everything.




- The equation shows how oxygen combines with sugars to break molecular bonds, releasing the energy (in the form of ATP). In addition to the energy released, the products of the reaction are carbon dioxide and water.

○ Students will be able to:

- Demonstrate the relationship between people and plants through the process of respiration
- Determine the change of chlorophyll pigments from the leaves of the plants
- Explain how cellular respiration allows organisms to use and release energy stored in the chemical bonds of glucose ($C_6H_{12}O_6$).

**Academic Language Knowledge and Skills**

- Students will know: The chlorophyll is essential for photosynthesis because of the color changes of the leaves.
- Students will be able to: Explain the process of cellular respiration, leaf chromatography and photosynthesis.

**English Language Development Knowledge and Skills (for starting, emerging, and developing ELLs)**

- Students will know: Vocabulary list: photosynthesis, greenhouse gases and greenhouse effect
- Students will be able to (define by audience, behavior, conditions): Use these terms in discussions with their peers and instructor.

## STAGE 2: DETERMINE ACCEPTABLE EVIDENCE

- Pre-requisite/Prior knowledge for Both Content and Language: N/A
- Formative Assessment for Both Content and Language:
    - Participants will be able to talk about what plants need in order to grow.
    - Participants will be able to explore the nature of the interaction between humans and plants.
    - Participants will be able to make simple experiments and explain their results

Other Forms of Assessment

Assessment Criteria

- Participants will be able to experiment and perform activities to investigate the relation between respiration and carbon dioxide and the pigments in a plant leaf
- Summative Assessment (N/A)

**Grouping Arrangements**

- Whole class
- Small group(s)
- Pairs
- Cooperative groups
- Individual

## STAGE 3: PLAN LEARNING EXPERIENCES

**Time Required for Segments**

- Set/Hook 15 minutes
- Teacher Input 30 minutes
- Guided Practice 40 minutes
- Closure 5 minutes

**Materials and Technology**

- Use the *People and Plants Lesson Plan* Handbook as an instructional tool.
- Participant weekly Surveys
- Materials: The instructor will need to collect materials and toolbox from the Columbia College Chicago at 623 S. Wabash, room 600N.
- Forms: Appendix 4– Pigment thin layer chromatography results

***Bubbling Carbon Dioxide Experiment***

- 100 ml White Vinegar
- 20 Straws
- 100 grams of Baking Soda
- 100 ml Universal Indicator
- 10 Balloons
- 10 Clear Cups

· 2 Empty Bottles

***Chromatography Experiment***

· 20 Filter Papers
· 20 Pencils (*Not included*)
· Leaves from plant experiments
· 60 ml Acetone/Alcohol (20 ml Per Tube)
· 10 Pennies (*Not included*)

**Technology:**

Instructors will need to get access at their site, to use computers and a projector.

o Using a projector, the instructor will continue discussion using *People and Plants* powerpoint and show the *Scientists for Tomorrow* website.

o Participants are encouraged to take video and pictures to explain their findings at <https://www.facebook.com/ScientistsforTomorrow>

**Teacher's Preparation**

- Review the *People and Plants (PP)* lesson plan and watch video tutorials beforehand.
- The instructor should arrive at the site 15-30 minutes prior to the start of class.
- As participants arrive, teacher should take attendance so they can fully complete instructor log afterwards.

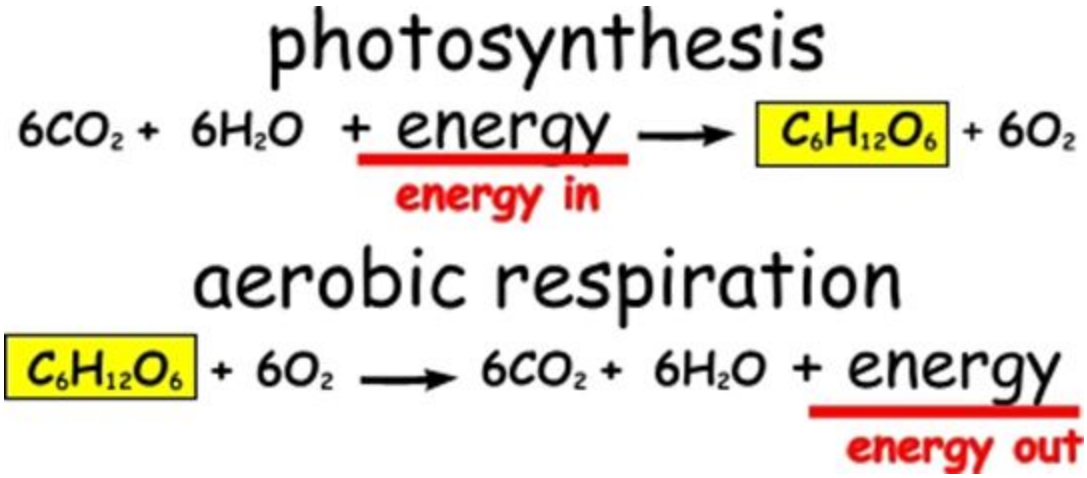
**Differentiated or Individualized Learning (i.e. non-reader, ELL-levels, gifted): N/A**

- **SET/HOOK**
  - The instructor will begin by reviewing some of the content reviewed from previous week. At this point, participants have completed long-term plant experiments. The instructor will activate this prior knowledge through a whole group discussion, being sure to address the necessary conditions for plant growth.
  - Instructor will ask the participants to write down their observations of the plants grown in the different plastics from the mini greenhouse. Students should look at the length of the shoots, colors of the leaves and observe the roots.

- Anticipated Time: 15 minutes
- Pre-requisite/prior knowledge: N/A
- Formative Assessment: Observation and participation

- **DEMONSTRATION/LECTURE:**

- In an open forum, while recording the responses on the board, the instructor will ask participants about what they observed from the plants that grew in the different mini greenhouses.
- The instructor will ask participants: What happened to the color of the leaves that were in the black plastic? What can be the reason the shoots of the stem grew longer? Have the students discuss with their peers what they observed.
- Students should know that in green plants both photosynthesis and respiration occur. In relatively bright light photosynthesis is the dominant process (meaning that the plant produces more food than it uses during respiration). At night, or in the absence of light, photosynthesis essentially ceases, and respiration is the dominant process; the plant consumes food (for growth and other metabolic processes).




- The two processes are shown in the simplified equation above. Photosynthesis absorbs energy (from sunlight) whereas aerobic respiration yields energy (as a result of the oxidation of glucose, the carbohydrate molecule shown here).

The instructor will explain the process of cellular respiration. All organisms produce Adenosine Triphosphate (ATP), a molecule that stores all the energy that comes from foods. All organisms produce ATP by releasing energy stored in glucose and other sugars. Adenosine Triphosphate (ATP) stores the energy humans' use to make just about everything.
Cellular Respiration is the process in which the chemical energy of molecules from "food" is released and partially stored in the molecular cellular form of ATP.

***Detecting Carbon Dioxide Experiment***: Instructor will perform an experiment to detect carbon dioxide using Universal Indicator (diluted in water).

- The instructor will put 40 mL white vinegar in an empty 0.5 L plastic transparent water bottle.
- Then the instructor will put 1 teaspoon of baking soda inside the balloon.

- Ensuring that the baking soda is in the body of the balloon, place the mouthpiece of the balloon around the neck of the plastic bottle with vinegar.

- Lift the balloon in the way that the baking soda falls from the balloon into the bottle with vinegar. (Note: A chemical reaction starts. The gas release by the reaction inflate the balloon. The gas released is carbon dioxide.)

$$C_2H_4O_2 + NaHCO_3 \longrightarrow NaC_2H_3O_2 + H_2O + CO_2$$

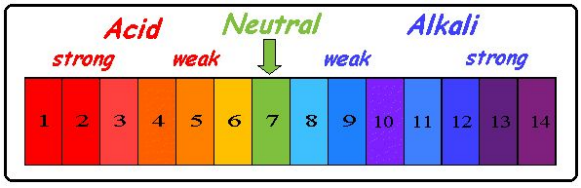
Acetic Acid Vinegar — Sodium Bicarbonate Baking Soda — Reactants^^ — Product^^

**Acetic Acid + sodium bicarbonate → sodium acetate(s) + water(l) + carbon dioxide(g)**
**(vinegar) (baking soda)**

- The balloon is full of … Carbon Dioxide!!!! but how to know that this gas is Carbon Dioxide?

Introduce the detection of carbon dioxide using Universal Indicator

Note that we can use a liquid called Universal Indicator to detect carbon dioxide. When carbon dioxide is added to water, carbonic acid is formed. When this reaction occurs in water containing universal indicator, there is a color change, resulting in yellow or red (see figure)




- Prepare a cup with 30mL of Universal Indicator. Carefully hold the balloon opening tightly, pull it from the bottle (without releasing the carbon dioxide) and gently wrap the opening of the balloon around the straw.
- Hold the balloon tight and put the other end of the straw into the cup with the Universal Indicator. Gently release the opening of the balloon to allow the gas inside of the balloon (carbon dioxide) into the cup with universal indicator. The release of the gas through the straw will make bubbles

The participants will see that the colour will start to change in the universal indicator solution, indicating that the solution is more acidic (turning yellow).

- This prove that the gas from the balloon reacting with the water of the indicator is making the solution acidic.
- Optional - If time allows it, let the participants to repeat the experiments in groups of two.

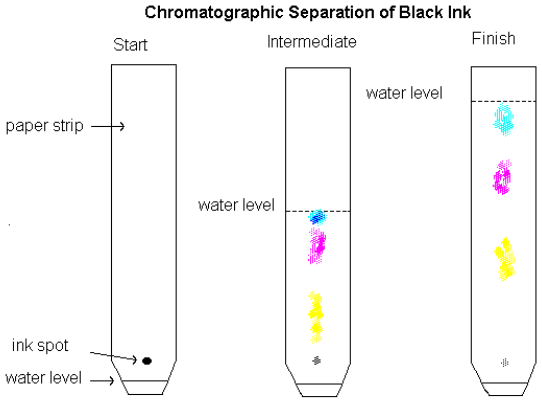
***Exploring human respiration***

- Prepare  a cup with 30 mL of Universal Indicator
- Using a straw breath into the cup. Observe that  the color will change similar to the previous experiment, where we released the gas of the balloon. This results support that the gas we exhale **<u>can be</u>** also carbon dioxide.

***Leaf Chromatography Experiment***

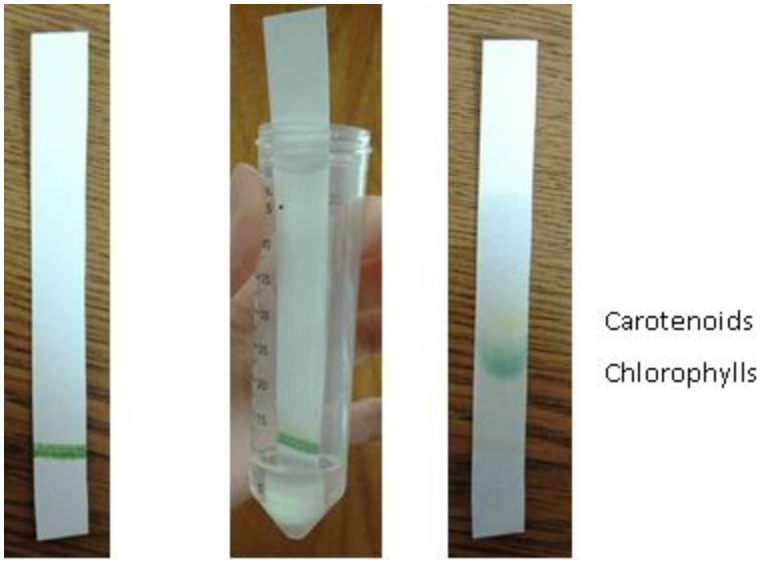
*What is chromatography*? It is a broad range of physical methods used to separate and or to analyze complex mixtures. The components to be separated are distributed between two phases: a *stationary phase* bed and a *mobile phase* which percolates through the stationary bed.

A mixture of various components enters a chromatography process, and the different components are flushed through the system at different rates. These differential rates of migration as the mixture moves over adsorptive materials provide separation. The smaller the affinity a molecule has for the stationary phase, the shorter the time spent in a column.



The black ink is made of three colours. each color has a different molecule size, then they will migrate at different velocities. Although the original colour of the ink was black, it is possible to see that this colour is made of three different colours. The same happens with the plants.

- Participants will observe the leaves from their long-term experiment.
- Leaves contain different pigments, which give them their color. Green chlorophyll is the most common type of pigment, but there are also cartenoids (yellow, orange) and anthocyanins (red). Chlorophyll, which is essential for photosynthesis, usually hides the other pigments, except when autumn comes along and it begins to break down. This is why leaves turn different colors in the fall
- The instructor will give each participant Appendix 4– Pigment thin layer chromatography results sheet to record the experiment.
- Participants will be divided into groups of three: The first group will get one large leaf from the black plastic sheeting; the second group will get a leaf from the 3.5m clear plastic sheeting; and the third group will get one leaf from the 2.5m clear plastic sheeting.
- Using a filter paper, each group will scratch the leaves using a penny, onto the filter paper.
- Add 20ml of acetone in a conical tube, and place the filter paper (leaf marked) inside.




- Wait for 30 minutes.
- As the acetone evaporates, it will pull the pigment up to the filter paper, separating pigments.
- The participants should observe the color change in the chromatogram activity. The darker the color, the brighter the chromatogram will be.
- Remove the strips and allow them to dry. Record Data.
- The instructor should ask the students, “Does the lighting affect the color pigment in the activity?” “Which leave had the most colorful pigment?”

- Anticipated Time: 45 minutes
- Pre-requisite/prior knowledge: Basic knowledge of photosynthesis
- Formative Assessment: Observation and participation

- **INDEPENDENT STUDENT PRACTICE**
- Participants should be encouraged to go online to learn about the various ways different plants grow.
- Participants should visit the *Scientists for Tomorrow* website www.scientistsfortomorrow.org, as well as following and posting pictures , video and reflections in Pinterest, Vimeo and Facebook, and use it as a resource for learning opportunities.
- **CLOSURE**
- Review of what was learned about the greenhouse, sun lighting and discuss next week's activity.
- The instructor will pass out the student weekly forms and discuss the importance to providing detailed feedback. (Hint: This will allow SfT staff to improve the program and find ways to engage the participants)

Instructor will complete and submit the activity journals to Scientists for Tomorrow.

- Anticipated Time: 5 minutes