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| **Name: Ashley Gregory** | **Contact Info: Ashley.gregory@boone.kyschools.us** | **Date: 01/13/16-01/25/16** |

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| **Lesson Title : Green Infrastructures** | **Unit #:**  **1** | **Lesson #:**  **2** | **Activity #:**  **3** |
| **Activity Title: Plant Roles in Green Infrastructures** |

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| **Estimated Lesson Duration:** | **9-10 class periods (47 minutes for each period)** |
| **Estimated Activity Duration:** | **3-4 class periods (47 minutes for each period)** |

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| **Setting:** | **Science classroom** |

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| **Activity Objectives:** |

* To explain the role of green infrastructures in an urban water cycle
* To research and identify plants that are found in green infrastructures
* To investigate plant processes (transpiration and photosynthesis)

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| **Activity Guiding Questions:** |

* What plants work best at filtering out contaminants from ground water?
* What are the features of plants that filter out storm water contaminants?
* What is a “green” infrastructure?

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☐ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☐ Developing and using models | ☒ Cause and effect |
| ☐ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☒ Systems and system models |
| ☐ Using mathematics and computational thinking | ☒ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☒ Structure and function. |
| ☐ Engaging in argument from evidence | ☐ Stability and change. |
| ☒ Obtaining, evaluating, and communicating information |  |

| **Ohio’s New Learning Standards for Science (ONLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☒ Demonstrating Science Knowledge **(D)** |
| ☒ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

| **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| ☐ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

**NGSS Standards:**

**07-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.**

**07-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of** **organisms.**

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

Day One Materials:

**Materials:**

***For each Group of 2 Students:***

6 Blue beads

18 Red beads

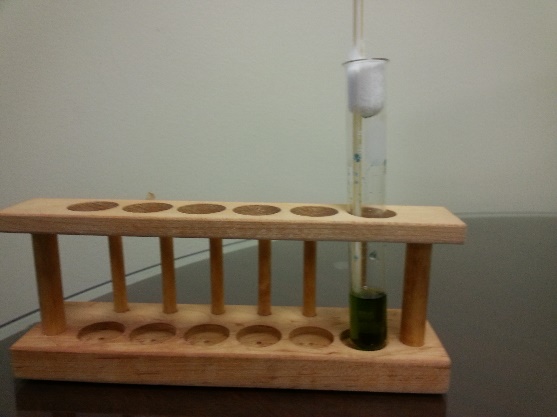
12 Green beads

1 Yellow Fuzzy Stick

12 Red 3-inch Fizzy Sticks

6 White 3-inch Fuzzy Sticks

Picture of Sun, leaf, photosynthesis equation, element symbol sheet, and directions (PowerPoint Attached)



***For each Student:***

Goggles

Test tube

Straw

Cotton ball

Bromothymol Blue Solution

6-8 Test Tube Racks

Day Two:

* Powerpoint presentation on Transpiration in Plants
* Guided notesheet on transpiration in plants (one for each student)

Day Three Materials:

* Computer and internet access for every student
* Website on transpiration in plants: <http://www.mhhe.com/biosci/genbio/virtual_labs/BL_10/BL_10.html>.
* Data table for every student

Day Four Materials:

* Computer and internet access for every student
* Websites for students to use to do research:

-<http://www.bettyhallphotography.com/resources/twenty-five-kentucky-native-plants-that-attract-birds-and-butterflies/>

-www.knps.org

-https://www.go-gba.org/resources/green-building-methods/rain-gardens-2/

-http://www.sciotogardens.com/sizing%20your%20rain%20garden.pdf

http://www.ci.owatonna.mn.us/sites/default/files/documents/Rain\_Garden\_Workshop\_Design\_2\_of\_4.pdf

* Cornell notetaking sheet (one for every student)

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| **Teacher Advance Preparation:** |

Day One:

* Set up test tubes with cotton balls, straws, and BB solution as described in the photosynthesis lesson (one for each student)
* Set up test tubes with Elodea plants and aluminum foil (demonstration only)
* Create a set of photosynthesis modeling kit for each pair of students (see lesson plan for details)

Day Two:

* Make copies of the guided notesheet (one for every student)

Day Three:

* Make copies of the data table (one for every student)

Day Four:

* Have Cornell notesheets ready (either on Google classroom or printed out) for students to use in their research

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| **Activity Procedures:** |

Day One:

Complete the following lesson plan on Photosynthesis:

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| **Title: Photosynthesis: Energy and Matter Flow** |
| **Summary:** Students will utilize a photosynthesis model which includes beads and pipe cleaners. They will discover the role of photosynthesis in the matter and energy flow into and out of organisms. Then students will construct an explanation regarding the role photosynthesis takes in the matter and energy flow into and out of organisms. |
| **Author:** Lila Brindley |
| **Grade level:** 7th Grade |
| **Materials:**  ***For each Group of 2 Students:***  6 Blue beads  18 Red beads  12 Green beads  1 Yellow Fuzzy Stick  12 Red 3-inch Fizzy Sticks  6 White 3-inch Fuzzy Sticks  Picture of Sun, leaf, photosynthesis equation, element symbol sheet, and directions (PowerPoint Attached)  20150115_160216  ***For each Student:***  Goggles  Test tube  Straw  Cotton ball  Bromothymol Blue Solution  6-8 Test Tube Racks  ***Preparation:***  Place an inch of Bromothymol Blue in a test tube with a straw. Tear a small piece of a cotton ball off and insert into the top of the test tube. This will ensure that no Bromothymol Blue is blown out of the test tube.  ***For Teacher:***  Grow with Your Learning Target –Learning Target Tri-board  Growing With Your LT  ***For each Group of 2 Students:***  Photosynthesis Puzzle Formative Assessment Picture Formative Assessment  20150115_135116  20150115_144151 |
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| **Learning Target(s):**  I can identify the energy and matter used and released in photosynthesis.  I can construct an explanation that describes the role of photosynthesis in the cycling of matter and flow of energy in organisms. |
| **ENGAGEMENT**   * Describe how the teacher will capture students’ interest. * What kind of questions should the students ask themselves after the engagement?   Show students the test tubes with Bromothymol Blue. Tell them it is a Respiratory Indicator, meaning it will change color in the presence of oxygen. Have students put on goggles, then demonstrate how to safely blow into the test tube. Hold the test tube in your hand and place your thumb over the cotton ball.  Ask students, “What happened to the color of the Bromothymol Blue? (It will turn green and then yellow) What gas were you blowing into the test tube? (Carbon dioxide) Are there other organisms that can use the carbon dioxide that humans (all animals) breathe out? (plants)  Show students the *Elodea* inside a test tube. Point out that you have 2 test tubes and one contains *Elodea* covered in aluminum foil. Have students check the test tubes at the end of the day to see if bubbles have formed on the leaves. What gas is inside the bubbles? |
| **EXPLORATION**   1. Describe what hands-on/minds-on activities students will be doing. 2. List “big idea” conceptual questions the teacher will use to encourage and/or focus students’ exploration   Explain to students that today they will be exploring the cycling of matter and the flow of energy into and out of organisms using photosynthesis. We will see how the carbon dioxide animals breathe out is used (recycled) by plants.  Have students set up their science notebook with name, date, and time on the front. The topic today is Photosynthesis.  Review learning target with students using the Grow with Your Learning Target – Learning Target Board.  **I can identify the energy and matter used and released in photosynthesis.**  **I can construct an explanation that describes the role of photosynthesis in the cycling of matter and flow of energy in organisms.**  Give every pair of students the Photosynthesis Directions (4 pages), box of beads, and bag of fuzzy sticks. Have the pairs of students lay the pages in a square on their table.  20150115_14511320150115_145058  Have students follow the directions to model the how energy and matter is used to create photosynthesis.  Once they complete the investigation, should create a technical drawing of the photosynthesis reaction. Make sure they start with the reactants going into their plant and end with the products produced, including where they go in their plant.  20150125_173536  20150125_173258  20150125_17361120150125_173846 |
| **EXPLANATION**   * Student explanations should precede introduction of terms or explanations by the teacher. What questions or techniques will the teacher use to help students connect their exploration to the concept under examination? * List higher order thinking questions which teachers will use to solicit *student* explanations and help them to justify their explanations.   What is photosynthesis? *The process that uses radiant energy, carbon dioxide, and water to produce glucose and oxygen.*  Why is photosynthesis important to all living things? *It creates the oxygen that is required for all animals to survive.*  Where is the energy needed to perform photosynthesis created? *The sun*  In what organisms does photosynthesis occur? *Plants and some bacteria*  What matter is needed for photosynthesis? *Radiant energy, carbon dioxide and water*  What matter is produced by photosynthesis? *Glucose and oxygen*  What is the role of photosynthesis in the cycling of matter? *Carbon and oxygen (CO2) from animal respiration is absorbed by the plant and is used to make glucose (food) for the plant. Hydrogen (H2O) is absorbed through the roots of plants and is used to make glucose (food) for the plant.*  What is the role of photosynthesis in the flow of energy? *The radiant energy from the sun is transferred to chemical energy that is either used immediately by the plant or stored for later use.*  What is the limitation of this model? *The red fuzzy sticks (thermal energy) is not released in photosynthesis.*  Show students a diagram below of Photosynthesis and specifically point out that thermal energy is NOT produced or released during this chemical reaction. This is a limitation of our model.    Ask students to tell you the parts of photosynthesis. Make a technical drawing on the board that incorporates their ideas. |
| **ELABORATION**   * Describe how students will develop a more sophisticated understanding of the concept. * What vocabulary will be introduced and how will it connect to students’ observations? * How is this knowledge applied in our daily lives?   Review vocabulary with students:  Reactant  Product  Radiant Energy  Chemical Energy  Make sure that students understand that the glucose created by photosynthesis is a form of chemical energy that can either be used by the plant immediately, stored by the plant for future used, or stored by the plant and eaten by another organism. The oxygen produced is used by all animals to breathe.  Have students use the same materials to model cellular respiration. |
| **EVALUATION**   * How will students demonstrate that they have achieved the lesson objective? * This should be embedded throughout the lesson as well as at the end of the lesson   Puzzle Formative Assessment   * Have students put together the photosynthesis puzzle. There are 2 variations. One has the words on the puzzle and the other has blanks to assess if students know what is happening during photosynthesis. * Have students construct an explanation (on the last 2 pages of their science notebook) for the role of photosynthesis in the cycling of matter and flow of energy in and out of organisms using the puzzle.   Picture Formative Assessment   * Have students put labels for photosynthesis on the picture. * Have students construct an explanation (on the last 2 pages of their science notebook) for the role of photosynthesis in the cycling of matter and flow of energy in and out of organisms using the picture. |
| **RESOURCES**  Photosynthesis Bead Activity  <http://www.pinterest.com/pin/413627546996737509/>  *But What IS Photosynthesis?* Beth Campbell. Western Michigan University.  <http://www.wmich.edu/engineer/ceee/edcsl/pdf/Photosynthesis.pdf> |

Day Two:

1. Pass out note sheet on transpiration. Using the Powerpoint presentation, have students take notes on transpiration in plants.

Day Three:

1. Pass out technology. Pass out transpiration data sheet. Have students go to the following website to complete an online virtual lab on transpiration in plants: <http://www.mhhe.com/biosci/genbio/virtual_labs/BL_10/BL_10.html>.
2. Discussion about the data/results.

Day Four:

* 1. Activity-Students will research plants in the Northern Kentucky area that can thrive in different amount of standing water/surface water.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

Day One: Puzzle Formative Assessment

* Have students put together the photosynthesis puzzle. There are 2 variations. One has the words on the puzzle and the other has blanks to assess if students know what is happening during photosynthesis.
* Have students construct an explanation (on the last 2 pages of their science notebook) for the role of photosynthesis in the cycling of matter and flow of energy in and out of organisms using the puzzle.

Picture Formative Assessment

* Have students put labels for photosynthesis on the picture.
* Have students construct an explanation (on the last 2 pages of their science notebook) for the role of photosynthesis in the cycling of matter and flow of energy in and out of organisms using the picture.

Day Three: Teacher will assess students during the discussion of the results of the plant transpiration activity. Teacher will ask very strategic questions to identify what the students learned from the activity. Teacher will also collect the activity worksheets to review.

Day Four: Teacher will collect research from the students to review.

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.  Refer to Activity Template for details. |

Kinesthetic learners will benefit from the hands-on transpiration and photosynthesis activity

Visual learners will benefit from the use of technology for the research of plants (teacher guided websites)

Auditory learners will benefit from the use of technology for the research of plants (teacher guided videos)

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

There were a lot of changes to this lesson!

Success: The project based learning teacher on my team decided to give the research assignment in her class. Students broke into groups and created a google slide presentation of native plants in northern Kentucky with high transpiration rates. She had them first fill out a Cornell notesheet with their research before they created their presentation. By doing the research in another class, I could focus more on the science standards and content of the project. She gave the students one week to do the research and to create the presentation.

Shortcoming AND success: Due to the time of year (winter), I could not do the transpiration lab with real plants. Instead, I found an online virtual lab for transpiration rates. The students seemed to really enjoy it and understood the experiment really well. The website is: <http://www.mhhe.com/biosci/genbio/virtual_labs/BL_10/BL_10.html>. So, instead of the lab, we spent one day taking notes on transpiration in plants, and then on the second day completed the online virtual lab. It worked out really well, and I think it was a great plan versus what I had originally wanted to do. The students were able to test 10 different plants against different type of environmental conditions like wind, heat, and excessive sunlight.

I also added on an activity about photosynthesis. I did this activity last year and the students loved it. Students use beads and pipe cleaners to model how matter is cycled in the process of photosynthesis. The activity concludes with students creating a technical drawing of photosynthesis in their science notebooks. I also had students create a comic strip of the process of photosynthesis as a homework assignment.