Photosynthesis Unit

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GRADE LEVEL

7
8

CONTENT TOPICS

Agriculture
Biology
Earth Science
Environmental Science
Life Science
Science

DESCRIPTION

This in-depth lesson collection is NGSS-aligned and part of a larger unit focused on Matter and Energy in Organisms and Ecosystems. Students are introduced to photosynthesis through phenomena, demonstrations and investigations. Students are provided opportunities to deepen understanding through five lessons culminating with the "Great CO^2 Race" investigation and an engineering challenge. Several extensions and differentiated learning opportunities are also provided.

SUGGESTED STANDARDS CONNECTIONS

NGSS	MS-ESS3-3
	MS-LS1-6
	MS-LS1-7
	MS-LS2-1
	MS-LS2-3
	MS-LS2-4

Photosynthesis Unit Overview

Topic
Photosynthesis

Class/Subject and Grade Level - The lessons were developed for 70 minute classes.
Science- 7th
Math- 7th and 8th

Description: This collection of lessons is part of a larger unit focused on Matter and Energy in Organisms and Ecosystems. Students are introduced to photosynthesis through a phenomena, demonstrations and investigations. Students are provided opportunities to deepen understanding through five lessons culminating with the "Great CO2 Race" investigation and an engineering challenge. Several extensions and differentiated learning opportunities are also provided.

Standards

Next Generation Science Standards (Science and Engineering)

- MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- MS-LS1-7: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
- MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Science/Engineering Practices (full descriptions):

- Asking questions and defining problems
- Plan and conduct an investigation
- Developing and using models (graphs, results from data-> graphs; using models to solve how photosynthesis works)
- Analyzing and interpreting data (results of CO2 graphs)
- Using mathematics and computational thinking (Photosynthesis and Cell Resp formulas)
- Constructing explanations and designing solutions
- Obtaining, evaluating and communicating information

Cross Cutting Concepts

- Energy and Matter (Photosynthesis and Cell Respiration)
- Scale, Proportions, and Quantity (Microscopes)
- Systems and System Models (A graph can be model)
- Structure and Function (cells & organelles)

International Society for Technology Education Standards (Technology)

Computational Thinker: 5b

- Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
- Students use microscopes responsibly
- Students use CO_2 (O_2 and light sensors optional)

Common Core Mathematics Standards (Mathematics)
CCSS.MATH.CONTENT.7.RP.A.2.B
Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.

CCSS.MATH.CONTENT.8.F.B.4

- Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x, y*) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

Lesson Objectives
The student will:

- Develop scientific explanations on the process of photosynthesis
- Use models to deepen understanding of inputs and outputs of photosynthesis
- Plan and conduct an investigation using plants and digital sensors
- Analyze and interpret data
- Communicate results orally and in writing
- Identify the linear relationships between light and CO_2 consumption and explain how manipulation of photosynthesis variables affects the linear relationship through line slope analysis.

Materials

- CO_2 and O_2 sensors - Available through STEM Pre-Academy. Fill out the digital participation form to join.
- Bromothymol Blue (BTB), available through Amazon
- Water - Deionized, distilled (no minerals)
- Light source
- Aluminum foil
- Elodea or other water plant.
- Straws
- Aquarium Pump
- Microscopes
- Plant cell samples
- Cell Stains (optional)

Safety Issues

- Microscope use and handling
- Require goggles when using BTB
- Go over proper handling of sensors
- Require every student uses a fresh straw for blowing CO_2 into BTB

Time	Teacher's Work	Students' Work	FAIR Features
Lesson 1 60-75'	• Prior to lesson - Train students proper care and use of microscopes • Prepare Microscopes and samples	Students explore plant structures through microscopy and begin to make structure function connections. • Conducted inquiries on basic needs of plants, and products of photosynthesis • Complete the photosynthesis formula (model) • Discuss energy and human connections	**Framework** Science and Engineering Practices NGSS Developing and Using Models; Obtaining, Evaluating, and Communicating Information **Assessment** Student are entering labeled diagrams and predictions of function in Science Journals **Integration** Science and Technology **Real World**

			Students make connections of photosynthesis to their lives and human society
Lesson 2 60-75'	Phenomena (Tree Growing Time Lapse.) driven lesson with student investigations deepening understanding of photosynthesis. After observing time-lapse video of tree growth student discuss essential questions: 1. How does mass change as plants grow? 2. Where does the increased mass come from? Activity Sequence: 1. Students complete lesson 1 questions 2. Bromothymol Blue (BTB) Introduction and demonstrations 3. Students use BTB to investigate photosynthesis and respiration using Elodea	Questions - Why does BMT turn green? What does it mean about CO_2 that it turns BMT green? How can we use this knowledge as a tool to investigate photosynthesis and/or respiration. Students set up Elodea investigation and document the setup and their predictions in science journals.	**Framework** Science and Engineering Practices NGSS ● Planning and conducting investigations ● Developing and Using Models; ● Obtaining, Evaluating, and Communicating Information **Assessment** Student are entering investigation setups, predictions, observations and inferences in their Science Journal. **Integration** Science and Technology **Real World** students use science practices to explore photosynthesis in action with water plants and a chemical pH indicator
Lesson 3 60-75'	Teacher provides guiding questions from Day 2 investigation and allow students to make observations and inferences. Teacher sets up CO2 sensors with leaves. Teacher guides students to identify controls and variable important for photosynthesis. Teacher reviews line slope and explains how the slope of the line for Time vs CO_2 provides information on rates of photosynthesis.	Student wrap up Elodea investigation observations and inference documented in science journals. Students, in their learning teams, diagram setup, identify controls, make predictions, discuss results and make inferences	**Framework** Science and Engineering Practices NGSS ● Obtaining, Evaluating, and Communicating Information ● Developing and Using Models; **Assessment** Student enter observations, predictions and inferences in their Science Journal. **Real World** Students collect and analyze data as scientists. **Integration** Science, Technology, and Math
Lesson 4	Now that students can explain what photosynthesis is and what the basic	Students diagram setup, identify controls, make	**Framework** Science and Engineering

Day 1 60-75’	requirements for plants are they will deepen their understanding through student-centered investigations, In groups of 2-4, students will use plant leaves that they collect at their school and will manipulate variables that could affect the photosynthesis rate and collect the data that is entered into their science journals.	predictions, discuss results and make inferences Students enter investigation observations and results into Science Journals	Practices NGSS ● Obtaining, Evaluating, and Communicating Information ● Developing and Using Models; **Real World** Students collect and analyze data as scientists. **Assessment** Student are entering investigation setups, predictions, observations and inferences in their Science Journal. Using plants form school allows students to understand that photosynthesis happens all around them, around the world and provides food and oxygen they need to live. **Integration** Math, Science, Technology: This lesson naturally integrates technology with the use of the sensors to collect the science data and the use of mobile devices and math skills to analyze the data.
Lesson 4 Day 2 60-75’ **DAY 4** 40 min	Now that students can explain what photosynthesis is and what the basic requirements for plants are they will deepen their understanding through student-centered investigations, In groups of 2-4, students will use plant leaves that they collect at their school and will manipulate variables that could affect the photosynthesis rate and collect the data that is entered into their science journals.		**Same as Day 1**
Lesson 5 Day 1 60-75’ Day 2 60-75’	Engineering design challenge to reduce atmospheric CO_2.	Students conduct background research on human activities contributing to CO_2 increases and climate change Students work on an engineering design challenge to	**Framework** Engineering Practices of NGSS **Assessment** This assessment is authentic in that students

		reduce atmospheric CO_2. Students document work in their engineering journals	**Integration** Engineering, Science, & Technology **Real World** Students are using the engineering design process to reduce CO_2 in the atmosphere