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# K-12 Partnership Lesson Plan

# Emily Grman

# *Into Thin Air*

# *What happens to leaves when they decompose?*

## Overview

Students will expand on their understanding of carbon cycling by measuring the concentration of CO2 and O2 in sealed containers with decomposing leaves. Students will gain experience using the Vernier LabQuest system with two gas sensors. They will also graph data and use the data to evaluate their predictions about what will happen to the carbon inside leaves.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Understand that most of a leaf’s mass goes into the air during decomposition
* Recognize the six major elements making up living tissue
* Understand why decomposition is a central step in carbon cycling

**Length of Lesson**

Setup: 60 min class period; Data collection: 20 min each day, 1 day per week, 3 weeks (?); Conclusion: two 60 min class periods

**Grade Levels**

8th grade

**Standards covered (NGSS)**

Disciplinary Core Ideas:

* **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**-**LS2-3**: develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem
* **MS**-**ESS2-1**: develop a model to describe the cycling of Earth’s materials and flow of energy that drives this process

Cross Cutting Concepts:

* Cause and effect
* Energy and matter in systems

Science and Engineering Practices

* Asking questions and defining problems
* Developing and using models
* Planning and carrying out investigations
* Analyzing and interpreting data
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **B1.1C**: conduct scientific investigations using appropriate tools and techniques (e.g. selecting an instrument that measure the desired quantity- length, volume, weight, time interval, temperature- with the appropriate level of precision)
* **B1.1D**: identify patterns in data and relate them to theoretical models
* **B1.1E**: describe a reason for a given conclusion using evidence from an investigation
* **B2.1B**: compare and contrast the transformation of matter and energy during photosynthesis and respiration
* **B2.2B**: recognize the six most common elements in organic molecules (C, H, N, O, P, S)
* **B2.2C**: describe the composition of the four major categories of organic molecules (carbohydrates, lipids, proteins, and nucleic acids)
* **B2.4f**: recognize and describe that both living and nonliving things are composed of compounds, which are themselves made up of elements joined by energy-containing bonds, such as those in ATP
* **B3.3b**: describe the environmental processes (e.g., the carbon and nitrogen cycles), and their role in processing matter crucial for sustaining life

**Materials**

* Quart size ziplock bags
* Topsoil
* Leaf litter
* Window screen, cut and sewed into bags approximately 4x4”
* Paper clips
* Balances
* Student worksheets
* Vernier LabQuest, CO2 gas sensor, O2 gas sensor
* Graph paper

**Background**

Ecological stoichiometry is the branch of ecology that seeks to explain how and why the elemental composition of organisms’ bodies are so different from their environment. The figure (from Sterner and Elser 2002) and table (from Mauseth 1998) below summarize the general pattern of elemental abundance in the earth’s crust, human bodies, and plant bodies. In general, organisms are enriched in nitrogen, phosphorus, and carbon relative to the abundance of useable forms of these elements in nature. (Remember that N2 and CO2, relatively abundant gases, must be turned into other compounds before they are useable.) The table in the answer key to the student worksheet explains what these nutrients are needed for. Sulfur, oxygen, and hydrogen are also essential components of living organisms, but they are rarely limiting and therefore receive little attention in the scientific literature. Carbon, nitrogen, and phosphorus cycling are all important concepts because C, N, and P are essential for life. C, N, and P cycling are all linked through decomposition.

Carbon cycles between inorganic (e.g., CO2) and organic (e.g., C6H12O6) forms. Decomposition is an essential step in this process, as are respiration and photosynthesis. Photosynthesis uses solar energy to transform CO2 into organic forms of carbon that can be used to build tissues and store that solar energy for later use; respiration and decomposition transform organic carbon molecules into CO2 and release the stored energy for use in cellular processes (moving, reproducing, etc).

### Activities of the session

1. Begin by finding out what students know about what plants are made of. If we zoomed all the way in on a leaf, what elements would we find?
2. Fill out the table on page 1 of the student worksheet- students will be able to guess at least O, H, P, and N from knowing what is in plant fertilizer and what is in water.
3. Where do plants get those things that their bodies are made of? (Animals get them by eating things made of those organisms- what do plants do instead of eat?)
4. Introduce the process toll by walking through a familiar process (photosynthesis)
5. Then use the process tool to explore decomposition and answer the rest of the questions in the worksheet. Pay special attention to the predictions section.
6. Move to the lab and build the experimental units:
   1. Have students fill their litterbags (mesh bags made of windowscreen) with dried leaves
   2. Make sure the students weigh their litterbags with leaves!
   3. Put the litterbags inside ziplocks and add soil and a little bit of water (soil should be good and damp but not soaking wet)
   4. Measure the initial CO2 and O2 in the air inside the bags
   5. Seal the bags!
   6. Label the bags and leave them in a warm, shady area
7. Come back the next day. Being careful not to let too much air into or out of the bag, measure CO2 and O2. Have they changed at all? Record the data in the data table in the student worksheets.
8. Repeat measurements as often as needed and for as long as needed.
9. At the end of the experiment, fold open the ziplock bags and let the contents air dry (at least a week)
10. When dry, remove the litterbags and weight them. Record the data on the student worksheet.
11. Hand out graph paper and have students graph their results.
12. Answer the discussion questions, either in small groups or as a class.



**Resources**

* Data on elemental composition of leaves taken from Table 2.2 in Mauseth, J. D. 1998. Botany: an introduction to plant biology (2nd edition). Jones and Bartlett, Sudbury, MA, USA.
* Data on elemental composition of the earth’s crust and human bodies taken from Sterner, R. W. and Elser, J. J. 2002. Ecological Stoichiometry: the biology of element from molecules to the biosphere. Princeton University Press, Princeton, NJ, USA.