Decomposers Unit Front Matter

Unit Home

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Decomposers is one of the six *Carbon TIME* units. If you are new to teaching *Carbon TIME*, read the *Carbon TIME* FAQ: Which Units Should I Teach.

The *Decomposers Unit* supports students in using core disciplinary ideas, science practices, and cross-cutting concepts to develop scientific explanations of how different decomposers *transform matter and energy* as they grow, move, and function.

Follow these steps to get ready to teach the *Decomposers Unit*

Step 1	Step 2	Step 3	Step 4	Step 5
Read The Unit Overview	Choose Your Unit Sequence	Learn About The Instructional Model & Storyline	Prepare Unit Materials	Dig Into The Lessons

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This unit is also available online at http://carbontime.bscs.org/. Contact the MSU Environmental Literacy Program for more information: EnvLit@msu.edu.

Overview

The Driving Question and Research Base

The *Decomposers Unit* starts by asking students to express their ideas about the driving question about an anchoring phenomenon, "What happens when bread molds?"

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Carbon is the key! In the unit, students learn to tell the story of how matter and energy are transformed as they move through decomposer systems. A particularly powerful strategy for explaining how decomposer systems transform matter and energy involves *tracing carbon atoms*. For more information about the *Next Generation Science Standards* **disciplinary core ideas** included in this unit see the sections on the Matter Movement, Matter Change, and Energy Change Questions below and the Unit Goals.

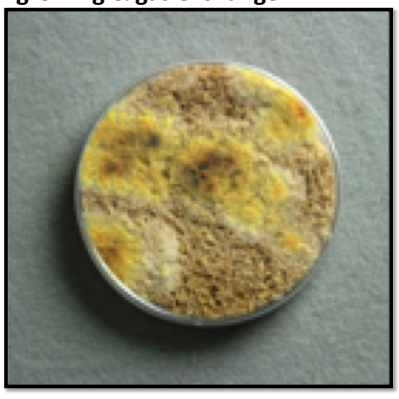
Research base. This unit is based on learning progression research that describes the resources that students bring to learning about decomposers and the barriers to understanding that they must overcome. It is organized around an instructional model that engages students in three-dimensional practices.

Students' Roles and Science Practices

As students learn to answer the driving question by explaining how decomposers transform matter and energy, they play three different roles that encompass all of the *Next Generation Science Standards* **science and engineering practices**. (For more details on science and engineering practices, see the Unit Goals.)

- Questioners: Students explore the driving question, clarify, and generate more detailed questions
- Investigators: Students conduct matter-tracing investigations of bread molding and develop evidence-based arguments about key observations and patterns
- Explainers: Students construct model-based explanations of how bread molds.

Investigation: Bread mold growing & gas exchange



Key observations and patterns

- The combined mass of the bread and the growing fungus goes down as the mold grows
- Molding bread emits CO_2 into the air

The roles that students play are embedded in the *Carbon TIME* Instructional Model and Discourse Routine. The Discourse Routine guides how classroom discourse aimed first at divergent thinking and then at convergent thinking should be sequenced through the unit.

Good Explanations Answer the Three Questions

Students figure out how to answer the driving question by tracing carbon-containing molecules through a series of movements and chemical changes inside decomposers. At each stage in these processes they answer Three Questions about what is happening: The *Matter Movement Question, the Matter Change Question,* and the *Energy Change Question.*

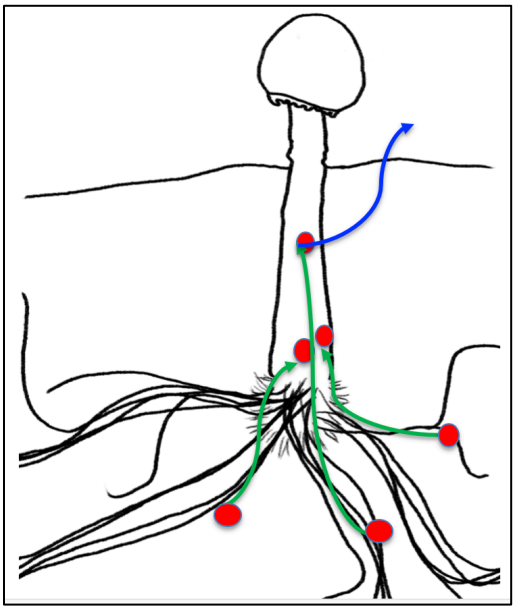
Below, we use the anchoring phenomenon of decomposers as an example of how students learn to answer the Three Questions for different decomposers.

Note that, in *Carbon TIME*, *NGSS* **crosscutting concepts** serve as the "rules of grammar" for producing a scientific performance. With respect to bread molding, high quality explanations should attend to the following rules that are implied by crosscutting concepts. Explanations should attend to:

- *Scale* by explaining events and phenomena at the appropriate scale (see more in the structure and function bullets below).
- *Systems and system models and energy and matter* by following rules for tracing matter and energy through systems and system models. For example, neither energy nor matter should be created or destroyed as it moves into, through, or out of a system.
- *Structure and function* by linking structures and functions in explanations at each scale.
    - Macroscopic scale (tracing matter and energy through processes occurring in fungus tissues and organs
    - Cellular scale (tracing matter and energy into and out of cells as cellular functions are carried out)
    - Atomic-molecular scale (tracing matter and energy through chemical processes—digestion, cellular respiration, and biosynthesis—involving molecules with different structures and properties)

The Matter Movement Question: Tracing Molecules Through Decomposers and Cells

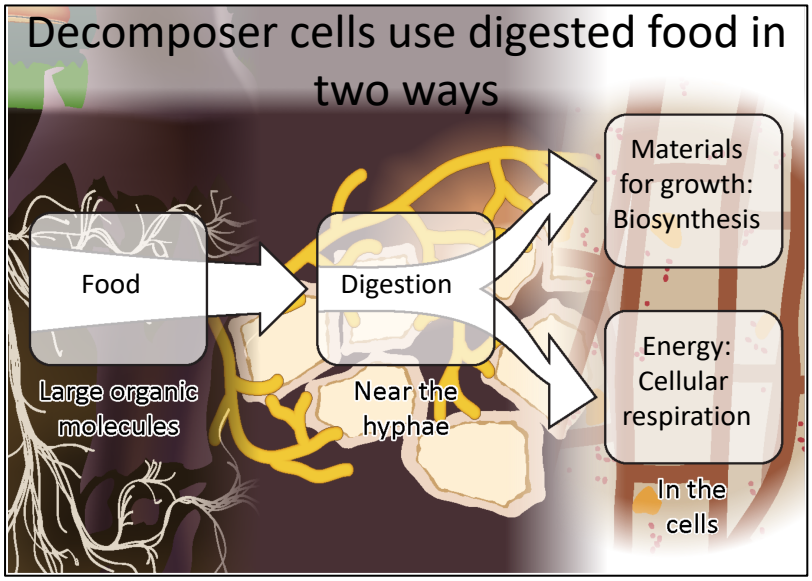
Students learn to tell the following story of how carbon-containing molecules move through decomposers.



- Decomposers (fungi and bacteria) live in places where there are large organic molecules (polymers or food) from dead plants or animals
- Decomposers excrete digestive enzymes that break large organic molecules into small organic molecules that enter the decomposers
- Some large organic molecules are not digested and remain in the environment
- Digested small organic molecules (monomers) containing carbon atoms move through fungal hyphae to all cells. Cells use these molecules to do the work that enables fungi to grow and function.
- All cells produce carbon dioxide that filters out of fungi and into the air, including air pockets in soil.

The Matter Change and Energy Change Questions: Explaining How Decomposers Use Organic Molecules to Grow, Move, and Function

Matter movement is an essential part of the story, but not the whole story. To answer the driving question, students learn to explain chemical changes that occur inside decomposers.



- *Digestion.* Large organic molecules (polymers) are broken down into small organic molecules (monomers) when bacteria or fungi release digestive enzymes into their food source. Both large and small organic molecules have chemical energy stored in their C-C and C-H bonds.
- *Biosynthesis and growth.* Bacteria and fungi grow when their cells grow and divide through the process of biosynthesis—combining small organic molecules from food to make the large organic molecules needed for cells' structure and function.
- *Cellular respiration—energy to move and function.* Cells of aerobic decomposers get the energy they need to move and function by combining sugars and other small organic molecules with oxygen, releasing energy when high-energy C-C and C-H bonds are replaced by lower-energy bonds in carbon dioxide and water. (Students can also study the anaerobic process of fermentation in Activity 6.1.)

How Much Detail?

There are more complicated and more scientifically accurate ways of talking about chemical bonds and about changes in energy; we discuss some of those in detail in our educator resource: *Carbon TIME* Content Simplifications. But our learning progression research has shown that there is an important tradeoff here—many students get lost in the details and never learn a basic coherent story that answers the driving question. The *Next Generation Science Standards* take a clear position on this tradeoff; a coherent story based on principles such as matter and energy conservation is more important than the details. Consult the Unit Sequence tab and the sections on Extending the Learning at the end of each Activity page to decide how much detail is appropriate for your students.

Unit Sequence

Before beginning the *Decomposers Unit*, you need to decide what to teach and importantly, what not to teach! Use this page to choose the unit sequence that's most appropriate for your students.

- Some activities are **REPEATING ACTIVITIES** (⊂⊃). **Omit these activities if students have already completed them in another unit (unless you'd like students to repeat them as review).**

- Other activities are **TWO-TURTLE ACTIVITIES** (), which place a higher demand on students. **Decide whether the higher demand required by these activities will be useful or distracting for y*our students*.** The *Carbon TIME* Turtle Trails document provides further info about choices for making units more or less demanding, depending on your students' needs.

Unless otherwise noted in the table below, all activities in the unit should be taught.

***Decomposers Unit* Sequence and Decisions Table**

Lesson	Activity Sequence	Feature	Make a Decision
Pre-Lesson (30 min)	0.1 Investigation Set Up (30 min)		The pre-lesson should be conducted at least seven days before you plan to begin the *Decomposers* Unit.
1 (60 min)	1.1 Decomposers Unit Pretest (20 min)		
	1.2 Expressing Ideas and Questions About Bread Molding (40 min)		
2 (2 hr 5 min)	2.1 Zooming Into Plants, Animals, And Decomposers (40 min)		These activities are exactly the same as equivalent ones in *Animals* and *Plants Units*. **Do not repeat these activities in multiple units unless students need a review.** Also, in Activity 2.1, the "Cells: The Building Blocks" reading is optional.
	2.2 Molecules Cells Are Made Of (45 min)		
	2.3 Molecules In Cells Quiz (20 min)		
	2.4 Questions About Decomposers (30 min)		
3 (2 hr 40 min)	3.1 Predictions and Planning About Bread Molding (50 min)		
	3.2 Observing Bread Molding (60 min over 2 days)		
	3.3 Evidence-Based Arguments For Bread Molding (50 min)		
4 (1 hr 20 min)	4.1 Molecular Models For Fungi Moving and Functioning (40 min)		The molecular modeling part of Activity 4.1 is the same as the molecular modeling for cellular respiration in the *Animals* and *Plants Units*. **Do not repeat unless for review.**
	4.2 Explaining How Fungi Move and Function: Cellular Respiration (40 min)		There are multiple scaffolds you can choose from to use with Activity 4.2 including the cellular respiration PPT, the Three Questions Checklist, example explanations, and a reading. Choose options that fit for your class at this time.
5 (2 hr	5.1 Tracing the Process of Decomposers Growing: Digestion and Biosynthesis (40 min)		

40 min)	5.2 Molecular Models For Fungi Growing: Digestion and Biosynthesis (40 min)		Activity 5.2 is exactly the same as molecular modeling for biosynthesis in the *Animals* and *Plants Units*. It's also a 2-turtle activity. **Consider skipping 5.2 if you've already taught it in another unit or if it's too advanced for your class.**
	5.3 Explaining How Fungi Grow: Digestion (40 min)		In Activities 5.3 and 5.4, you can choose from among similar scaffolding tools as those listed for Activity 4.2
	5.4 Explaining How Fungi Grow: Biosynthesis (40 min)		
6 (varies)	**(Optional)** 6.1 Exploring Different Kinds of Decomposers (varies)		Activity 6.1 allows students to learn more about decomposers through readings and activities. It is the only activity in the unit that addresses anaerobic decomposition. **Decide if and what parts of this activity your students will complete.**
	6.2 Explaining Other Examples of Decomposers Growing, Moving, and Functioning (50 min)		Activity 6.2 has explanations about 3 different fungi. **Consider a jigsaw format with different students becoming experts on different fungi and then sharing/comparing.**
	6.3 Comparing Decomposers, Plants, and Animals (50 min)		In Activity 6.3, students will compare decomposers, plants, and animals.
	6.4 Functions of All Decomposers (50 min)		In Activity 6.4, students will develop an explanation that applies to all decomposers.
	6.5 Decomposers Unit Posttest (40 min)		

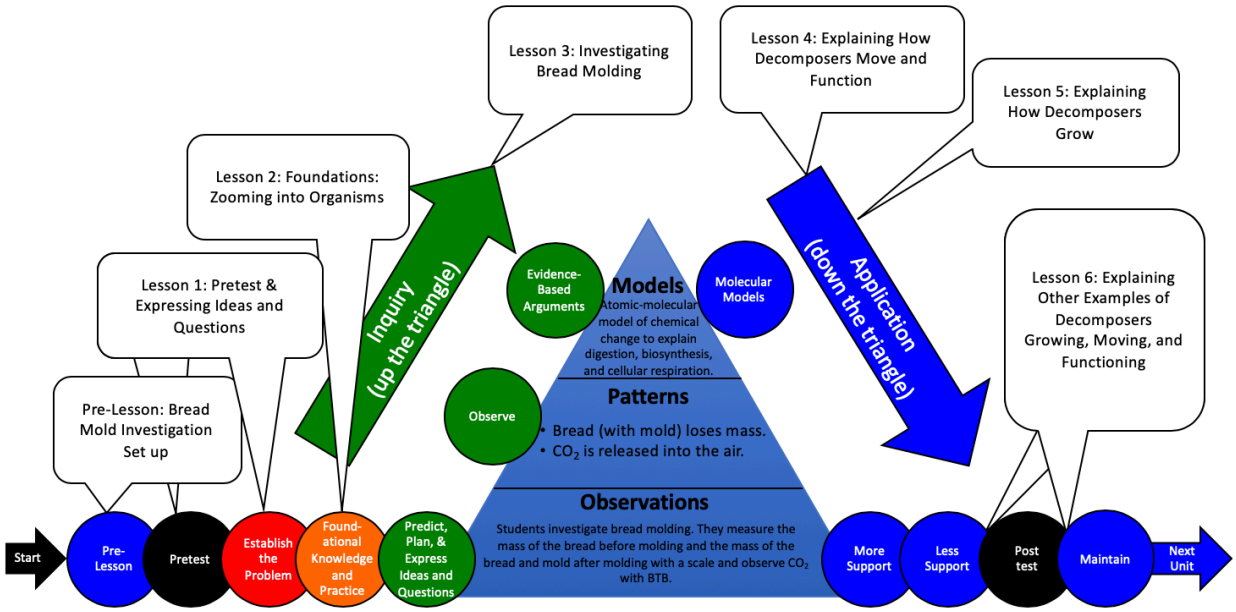
IM & Storyline

Here, we present two ways to think about how lessons are sequenced in the *Decomposers Unit*. The Instructional Model, immediately below, emphasizes how students take on roles of questioner, investigator, and explainer to learn and apply scientific models they can use to answer the driving question. Further below, the Unit Storyline Chart highlights the central question, activity, and answer that students engage with in each lesson of the *Decomposers Unit*.

Instructional Model

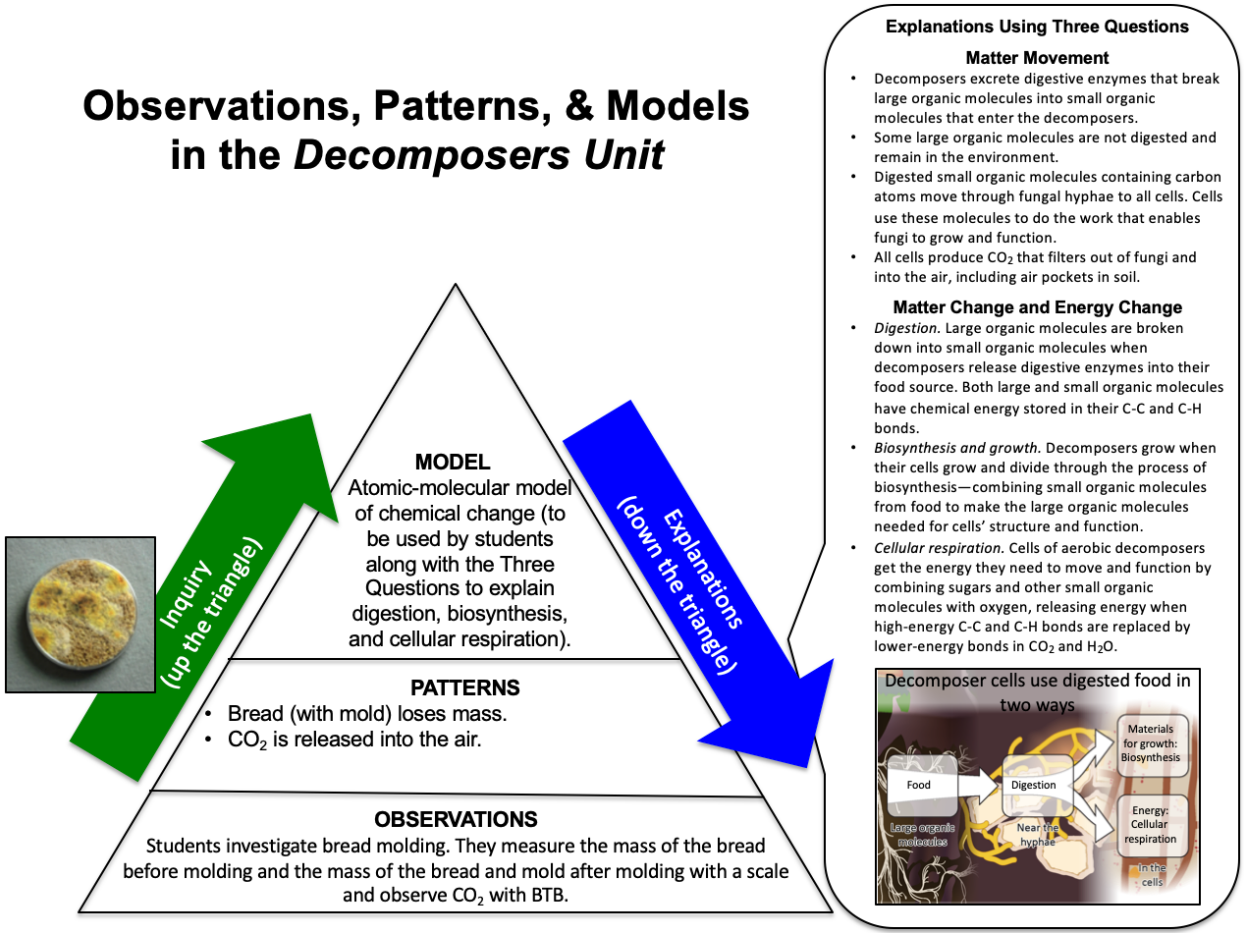
Like all *Carbon TIME* units, this unit follows an instructional model (IM) designed to support teaching that helps students achieve mastery at answering the driving question through use of disciplinary content, science practices, and crosscutting concepts. To learn more about this design, see the *Carbon TIME* Instructional Model.

The *Decomposers* Unit



The core of the *Carbon TIME* IM is the Observation, Patterns, Models (OPM) triangle, which summarizes key aspects to be attended to as the class engages in unit inquiry and explanation. The OPM triangle for the *Decomposers Unit*, shown below, articulates the key observations students make during the unit investigation, the key patterns they identify through analyzing their investigation data, and the central scientific model that can be used to answer the unit's driving question. During the inquiry portion of the unit (Lesson 3), the class moves from making observations to identifying patterns, eventually using these patterns to make evidence-based arguments. During the explanation portion of the unit (Lessons 4, 5, and 6), the class learns the atomic-molecular model, makes connections across scales, and uses the atomic-molecular model to explain how decomposers grow, move, and function. Across the unit, classroom discourse is a necessary part of 3-dimensional *Carbon TIME* learning. The Carbon TIME Discourse Routine document provides guidance for scaffolding this discourse in lessons.

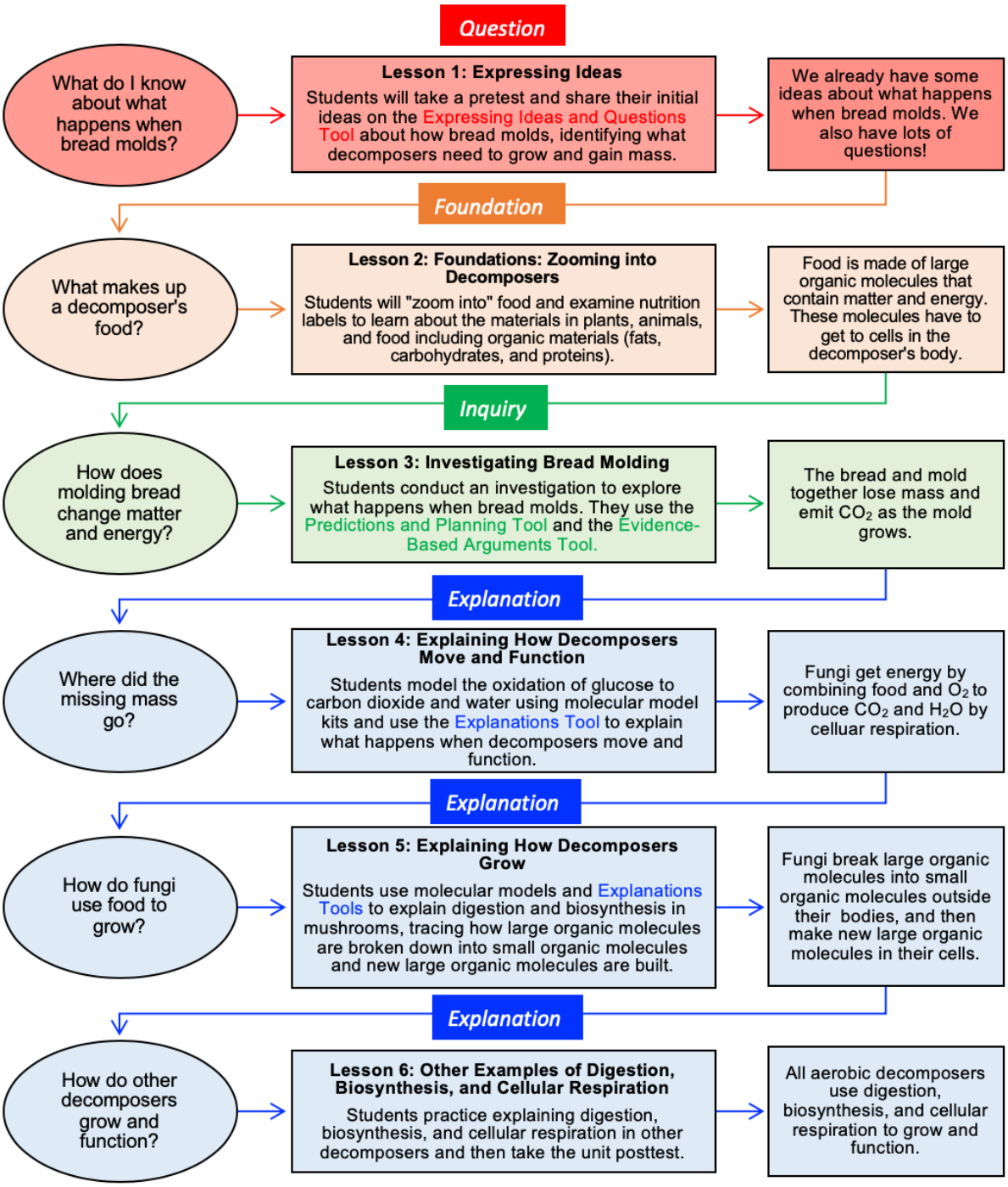
Observations, Patterns, Models, and Explanations in the Decomposers Unit



Unit Storyline Chart

Another way to familiarize yourself with the sequence of lessons in the *Decomposers Unit* is with the Unit Storyline Chart depicted below. The Unit Storyline Chart summarizes a unit phenomenon-based driving question associated with each lesson, what classes will do in each lesson to address the question, what conclusions they will come to, and how they will transition to a subsequent lesson.

Download PDF of IM and Unit Storyline Chart



Unit Goals

The tables below show goals for this unit in two forms. A table showing specific target performances for each activity is followed by a list of the *Next Generation Science Standards (NGSS)* addressed by this unit.

Target Performances for Each Activity

Download PDF of Unit Target Performances

All *Carbon TIME units* are organized around a common purpose: *assessing and scaffolding students' three-dimensional engagement with phenomena.* Every *Carbon TIME* activity has its specific expectation for students' three-dimensional engagement with phenomena, what we call its **target performance**. Each activity also includes tools and strategies that teachers can use to asses and scaffold the target performance in rigorous and responsive ways.

The target performances for each activity in the *Decomposers* unit are listed in the table below.

Activity	***Target Performance***
Activity 0.1: Investigation Set Up	Students will make initial measurements of the combined mass of a slide of bread and a Petri dish and leave the bread to mold.
Lesson 1 – Pretest and Expressing Ideas and Questions (students as questioners)	
Activity 1.1: *Decomposers* Unit Pretest	Students show their initial proficiencies for the overall unit goal: Questioning, investigating, and explaining how decomposers move and change matter and energy as they live and grow.
Activity 1.2: Expressing Ideas and Questions about Bread Molding	Students ask and record specific questions about changes in matter and energy in response to the unit driving question: What happens when bread molds?
Lesson 2 – Foundations: Zooming into Organisms (students developing foundational knowledge and practice)	
Activity 2.1: Zooming into Plants, Animals, and Decomposers	Students "zoom in" to animals, plants, and decomposers, describing how all of these organisms are made of cells with special structures and functions.
Activity 2.2: Molecules Cells Are Made of	Students use food labels to describe molecules in animal, plant, and decomposer cells: large organic molecules (carbohydrates, proteins, and fats), as well as water, vitamins, and minerals.
Activity 2.3: Molecules in Cells Quiz	Students complete a quiz to assess their understanding of the molecules in cells and how to identify which molecules store chemical energy.
Activity 2.4: Questions about Decomposers	Students describe structures and functions that all decomposers share and pose questions about molding bread to prepare for their upcoming investigation.

Activity	***Target Performance***
Lesson 3 – Investigating Bread Molding (students as investigators and questioners)	
Activity 3.1: Predictions and Planning about Bread Molding	Students (a) develop hypotheses about how matter moves and changes and how energy changes when bread molds and (b) make predictions about how they can use their investigation tools—digital balances and BTB—to detect movements and changes in matter.
Activity 3.2: Observing Bread Molding	Students record data about changes in mass and BTB when bread molds and reach consensus about patterns in their data.
Activity 3.3: Evidence-Based Arguments for Bread Molding	Students (a) use data from their investigations to develop evidence-based arguments about how matter moves and changes and how energy changes when bread molds, and (b) identify unanswered questions about matter movement and matter and energy change that the data are insufficient to address.
Lesson 4 –Explaining How Decomposers Move and Function (students as explainers)	
Activity 4.1: Molecular Models for Fungi Moving and Functioning: Cellular Respiration	Students use molecular models to explain how carbon, oxygen, and hydrogen atoms are rearranged into new molecules in fungus cells.
Activity 4.2: Explaining How Fungi Move and Function: Cellular Respiration	Students explain how matter moves and changes and how energy changes during cellular respiration in fungus cells.
Lesson 5 – Explaining How Decomposers Grow (students as explainers)	
Activity 5.1: Tracing the Processes of Fungi Growing: Digestion and Biosynthesis	Students “zoom in” to the structure and function of a mushroom’s organ systems and cells, tracing atoms and energy.
(Optional) Activity 5.2: Molecular Models for Fungi Growing: Digestion and Biosynthesis	Students use molecular models to explain how polymers are broken into monomers during the process of digestion and monomers are linked into polymers during biosynthesis.
Activity 5.3: Explaining How Fungi Grow: Digestion	Students explain how matter moves and changes and how energy changes during digestion by a fungus.
Activity 5.4: Explaining How Fungi Grow: Biosynthesis	Students explain how matter moves and changes and how energy changes during biosynthesis in a mushroom’s cells.

Activity	***Target Performance***
Lesson 6 – Explaining Other Examples of Decomposers Growing, Moving, and Functioning (students as explainers)	
(Optional) Activity 6.1: Exploring Different Kinds of Decomposers	Students explain how matter and energy move and change in other phenomena involving decomposers, included aerobic and anaerobic bacteria, fermentation, spontaneous combustion of hay, and decomposition in forests.
Activity 6.2: Explaining Other Examples of Decomposers Growing, Moving, and Functioning	Students develop integrated accounts of how other fungi (bracket fungi, bread mold, mycorrhizal fungi) grow and function through the processes of digestion, cellular respiration, and biosynthesis.
Activity 6.3: Comparing Decomposers, Plants, and Animals	Students compare how matter moves and changes and how energy changes in decomposers, plants, and animals.
Activity 6.4: Functions of All Decomposers	Students develop integrated accounts of how all aerobic decomposers grow and function through the processes of digestion, cellular respiration, and biosynthesis.
Activity 6.5: Decomposers Unit Posttest	Students show their end-of unit proficiencies for the overall unit goal: Questioning, investigating, and explaining how decomposers move and change matter and energy as they live and grow.

Next Generation Science Standards

The *Next Generation Science Standards* (*NGSS*) performance expectations that middle and high school students can achieve through completing the *Decomposers* Unit are listed below. To read a discussion of how the *Carbon TIME* project is designed to help students achieve the performances represented in the NGSS, please see Three-dimensional Learning in *Carbon TIME*.

High School

- Chemical Reactions. HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy. http://www.nextgenscience.org/hsps-cr-chemical-reactions
- Chemical Reactions. HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. http://www.nextgenscience.org/hsps-cr-chemical-reactions
- From Molecules to Organisms: Structures and Processes. HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. http://www.nextgenscience.org/msls1-molecules-organisms-structures-processes
- Matter and Energy in Organisms and Ecosystems. HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar

molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
http://www.nextgenscience.org/hsls-meoe-matter-energy-organisms-ecosystems

- Matter and Energy in Organisms and Ecosystems. HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
http://www.nextgenscience.org/hsls-meoe-matter-energy-organisms-ecosystems
- Matter and Energy in Organisms and Ecosystems. HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
http://www.nextgenscience.org/hsls-meoe-matter-energy-organisms-ecosystems

Middle School

- Structure and Properties of Matter. MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.
http://www.nextgenscience.org/msps-spm-structure-properties-matter
- Chemical Reactions. MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
http://www.nextgenscience.org/msps-cr-chemical-reactions
- Chemical Reactions. MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
http://www.nextgenscience.org/msps-cr-chemical-reactions
- From Molecules to Organisms: Structures and Processes. MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
http://www.nextgenscience.org/msls1-molecules-organisms-structures-processes
- Matter and Energy in Organisms and Ecosystems. 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.
http://www.nextgenscience.org/msls-meoe-matter-energy-organisms-ecosystems
- Matter and Energy in Organisms and Ecosystems. MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
http://www.nextgenscience.org/msls-meoe-matter-energy-organisms-ecosystems

Materials

Recurring Resources:

- Three Questions 11 x 17 Poster (1 per class)
- Three Questions Handout (1 per student)
- BTB Color Handout (1 per group)
- Molecular Models 11 x 17 Placemat (1 per pair of students)
- Investigation Planning Tool
- (Optional for more demanding classes) Posters about large organic molecules:
    - Digestion and Biosynthesis of Carbohydrates 11 x 17 Poster (1 per class)
    - Digestion and Biosynthesis of Fat 11 x 17 Poster (1 per class)
    - Digestion and Biosynthesis of Protein 11 x 17 Poster (1 per class)
- Molecule 11 x 17 Poster (1 per class)

- Metabolic Pathways Poster: http://www.sigmaaldrich.com/content/dam/sigma-aldrich/docs/Sigma/General_Information/metabolic_pathways_poster.pdf (1 per class)
- Three Ways to Represent Glucose 11 x 17 Poster (1 per class)
- Forms of Energy Cards (1 set per pair of students)
- Driving Questions Board
- Bread Mold Class Results 11 x 17 Poster
- Bread Mold Class Results Spreadsheet
- Decomposer 11 x 17 Poster (1 per class)
- Questions, Connections, Questions Student Reading Strategy
- Engaging Students with Readings and the Question, Connections, Questions Reading Strategy Educator Resource
- Learning Tracking Tool for Decomposers (1 per students)
- Assessing the Learning Tracking Tool for Decomposers
- Decomposers Matter Tracing Tool (1 per student)
- Assessing the Decomposers Matter Tracing Tool
- Big Idea Probe: Leaf Pack Experiment (1 per student)
- Assessing the Big Idea Probe: Leaf Pack Experiment
- Using Big Idea Probes
- Big Idea Probe: Leaf Pack Experiment (1 per student)
- Assessing the Big Idea Probe: Leaf Pack Experiment
- Example Decomposers Explanations Handout (1 per student or group)
- *Carbon TIME* Bread Molding Video

Materials You Provide:

Pre-Activity 0.1: Investigation Set Up (30 min)

- Bread slices (4 per group of students)
- Digital Balance (1 per group of students)
- Labels for Petri dishes (4 per group of students)
- Permanent marker (1 per group of 4 students)
- Petri dishes with lids (4 per group of students)
- Roll of tape (1 per group or class)
- Spray bottle with water for misting the bread (1 per group or class)

Activity 1.1: Decomposers Unit Pretest (20 min)

- pencils (1 per student)

Activity 1.2: Expressing Ideas and Questions about Bread Molding (30 min)

- sticky notes (1 per student)
- Time Lapse Videos of Decomposition: http://www.plantpath.cornell.edu/PhotoLab/timelapse.html

Activity 2.3: Molecules in Cells Quiz (20 min)

- Pencils (1 per student)

Activity 2.4: Questions about Decomposers (30 min)

- (From previous lesson) 1.2 Expressing Ideas and Questions Tool for Bread Molding

Activity 3.1: Predictions and Planning about Bread Molding (50 min)

- (From previous lesson) Students' ideas and questions they shared in Activity 1.2 Expressing Ideas and Questions for Bread Molding
- (From previous lesson) 1.2 Expressing Ideas and Questions Tool for Bread Molding

Activity 3.2: Observing Bread Molding (60 min over 2 days)

- bromothymol blue (BTB) solution (less than 1 cup per group of four students)
- digital balance (1 per group of four students)
- plastic Petri dish (1 per group of four students)
- labeled Petri dishes with moldy bread from the Pre-Lesson (1 per student)
- sealable, 9.5 cup container (1 per group of four students)
- (From previous lesson) Completed Pre 0.1 Bread Mold Investigation Set Up Worksheet
- (From previous lesson) Bread Mold Investigation Class Results 11 x 17 Poster (or Spreadsheet)

Activity 3.3: Evidence-Based Arguments about Bread Molding (50 min)

- (From previous lesson) 3.2 Observing Bread Molding Worksheet

Activity 4.1: Molecular Models for Fungi Moving and Functioning: Cellular Respiration (40 min)

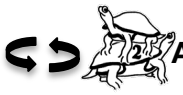
- (From previous lesson) Students' unanswered questions they shared in Activity 3.3 Evidence-Based Arguments for Bread Molding
- (From previous lesson) 3.3 Evidence-Based Arguments Tool for Bread Molding
- molecular model kit (1 per pair of students)
- scissors (1 per pair of students)
- twist ties (at least 12 per pair of students)
- video of decomposers moving, such as here https://www.youtube.com/watch?v=3CPCFV46HDs

Activity 4.2: Explaining How Fungi Move and Function: Cellular Respiration (40 min)

- (From previous lesson) 3.3 Evidence-Based Arguments Tool for Bread Molding

Activity 5.1: Tracing the Process of Fungi Growing: Digestion and Biosynthesis (40 min)

- pennies (10 per pair of students)
- nickels (3 per pair of students)
- video of a fungi growing, such as here: http://www.plantpath.cornell.edu/PhotoLab/TimeLapse2/Amanita1_credits4_FC.html



Activity 5.2: Molecular Models for Fungi Growing: Digestion and Biosynthesis (40 min)

- scissors (1 per pair of students)
- removable or re-stick tape (1 dispenser per pair of students)

Activity 5.3: Explaining How Fungi Grow: Digestion (40 min)

- (From previous lesson) 3.3 Evidence-Based Arguments for Bread Molding

Activity 5.4: Explaining How Fungi Grow: Biosynthesis (40 min)

- (From previous lesson) 3.3 Evidence-Based Arguments for Bread Molding

(Optional) Activity 6.1: Exploring Different Kinds of Decomposers (varies)

- Spontaneous combustion of hay video: https://www.youtube.com/watch?v=zRNCrHqD0zE

- Paper for writing answers to questions on 6.1 Exploring Different Kinds of Decomposers Handout
- Molecular model kits for modeling fermentation (if you do 6.1 Decomposers Without Oxygen Reading and Modeling)

Activity 6.2: Explaining Other Examples of Decomposers Growing, Moving, and Functioning (50 min)

- (from previous lesson) 1.2 Expressing Ideas and Questions Tool for Bread Molding
- (from previous lesson) 3.3 Evidence-Based Arguments Tool for Bread Molding

Activity 6.4: Functions of All Decomposers (50 min)

- computers (1 per pair of students, for option 2 in step 6)
- blank posters (1 per pair of students or small group, for option 3 in step 6)

Activity 6.5: Decomposers Unit Posttest (20 min)

- pencils (1 per student)

Resources Available on the Website:

Pre-Activity 0.1: Investigation Set Up (30 min)

- Pre 0.1 Bread Mold Investigation Set Up Worksheet (1 per student)

Activity 1.1: Decomposers Unit Pretest (20 min)

- Decomposers Unit Pretest (1 per student)
- Assessing the Decomposers Unit Pretest

Activity 1.2: Expressing Ideas and Questions about Bread Molding (30 min)

- 1.2 Expressing Ideas and Questions about Bread Molding PPT
- 1.2 Expressing Ideas and Questions Tool for Bread Molding (1 per student)
- 1.2 Assessing the Expressing Ideas and Questions Tool for Bread Molding
- 1.2 Decomposers Storyline Reading: Learning from the Work of a Ph.D. in Forest Ecology (1 per student)

Activity 2.1: Zooming into Plants, Animals, and Decomposers (40 min)

- 2.1 Zooming into Plants, Animals, and Decomposers PPT

Activity 2.2: Molecules Cells Are Made Of (45 min)

- 2.2 Food Labels Worksheet (1 per student)
- 2.2 Grading the Food Labels Worksheet
- 2.2 Molecules Cells Are Made of PPT
- 2.2 Reading Nutrition Labels Handout (1 per pair of students)
- 2.2 Food Label Cards (1 per pair of students)

Activity 2.3: Molecules in Cells Quiz (20 min)

- 2.3 Molecules in Cells Quiz (1 per student)
- 2.3 Grading the Molecules in Cells Quiz

Activity 2.4: Questions about Decomposers (30 min)

- 2.4 Questions about Decomposers PPT

Activity 3.1: Predictions and Planning about Bread Molding (50 min)

- 3.1 Predictions and Planning about Bread Molding PPT
- 3.1 Predictions and Planning Tool for Bread Molding (1 per student)
- 3.1 Assessing the Predictions and Planning Tool for Bread Molding

Activity 3.2: Observing Bread Molding (60 min over 2 days)

- 3.2 Observing Bread Molding Worksheet (1 per student)
- 3.2 Grading the Observing Bread Molding Worksheet
- 3.2 Observing Bread Molding PPT

Activity 3.3: Evidence-Based Arguments for Bread Molding (50 min)

- 3.3 Evidence-Based Arguments Tool for Bread Molding (1 per student)
- 3.3 Assessing the Evidence-Based Arguments Tool for Bread Molding
- 3.3 Evidence-Based Arguments Tool for Bread Molding PPT

Activity 4.1: Molecular Models for Fungi Moving and Functioning: Cellular Respiration (40 min)

- 4.1 Molecular Models for Cellular Respiration Worksheet (1 per student)
- 4.1 Grading the Molecular Models for Cellular Respiration Worksheet
- 4.1 Molecular Models for Fungi Cellular Respiration PPT

Activity 4.2: Explaining How Fungi Move and Function: Cellular Respiration (40 min)

- 4.2 Explanations Tool for Fungi Cellular Respiration (1 per student)
- 4.2 Explaining How Fungi Move and Function: Cellular Respiration PPT
- 4.2 Grading the Explanations Tool for Fungi Cellular Respiration
- 4.2 How do Decomposers Get the Energy They Need to Move and Function? Reading (1 per student)

Activity 5.1: Tracing the Processes of Fungi Growing: Digestion and Biosynthesis (40 min)

- 5.1 Tracing the Processes of Fungi Growing: Digestion and Biosynthesis PPT
- 5.1 Tracing Atoms and Energy in Fungi Worksheet (1 per student)
- 5.1 Grading the Tracing Atoms and Energy in Fungi Worksheet
- 5.1 Tracing the Process for Fungi Growing: Digestion and Biosynthesis Directions (1 per student or pair of students)

Activity 5.2: Molecular Models for Fungi Growing: Digestion and Biosynthesis (40 min)

- 5.2 Molecular Models for Fungi Growing: Digestion and Biosynthesis PPT
- 5.2 Polymers for Cutting Handout (1 copy for every four students)

Activity 5.3: Explaining How Fungi Grow: Digestion (40 min)

- 5.3 Explaining How Fungi Grow: Digestion PPT
- 5.3 Explanations Tool for Fungi Digestion (1 per student)
- 5.3 Grading the Explanations Tools for Fungi Digestion
- (Optional) 5.3 How do Decomposers Digest Food? Reading (1 per student)

Activity 5.4: Explaining How Fungi Grow: Biosynthesis (40 min)

- 5.4 Explaining How Fungi Grow: Biosynthesis PPT
- 5.4 Explanations Tool for Fungi Biosynthesis (1 per student)
- 5.4 Grading the Explanations Tools for Fungi Biosynthesis

- (Optional) 5.4 How do Decomposers Grow? Reading (1 per student)

(Optional) Activity 6.1: Exploring Different Kinds of Decomposers (varies)

- 6.1 Exploring Different Kinds of Decomposers Handout (1 per student)
- 6.1 Bacteria Reading
- 6.1 Dr. Death Reading
- 6.1 Decomposers Without Oxygen Reading and Modeling Handout

Activity 6.2: Explaining Other Examples of Decomposers Growing, Moving, and Functioning (50 min)

- 6.2 Explaining Other Examples of Decomposers Growing, Moving, and Functioning PPT
- 6.2 Other Decomposers Reading: Bracket Fungi
- 6.2 Other Decomposers Reading: Bread Mold
- 6.2 Other Decomposers Reading: Mycorrhizal Fungi
- 6.2 Bracket Fungi Worksheet
- 6.2 Bread Mold Worksheet
- 6.2 Mycorrhizal Fungi Worksheet
- 6.2 Grading Bracket Fungi Worksheet
- 6.2 Grading Bread Mold Worksheet
- 6.2 Grading Mycorrhizal Fungi Worksheet

Activity 6.3: Comparing Decomposers, Plants, and Animals (50 min)

- 6.3 Comparing Decomposers, Plants, and Animals PPT
- 6.3 Comparing Decomposers, Plants, and Animals Worksheet (1 per student)
- 6.3 Grading the Comparing Decomposers, Plants, and Animals Worksheet

Activity 6.4: Functions of All Decomposers (50 min)

- 6.4 Functions of All Decomposers PPT
- 6.4 Explaining Functions that All Decomposers Share Worksheet (1 per student for option 1 in step 3)
- 6.4 Grading the Explaining Functions that All Decomposers Share Worksheet

Activity 6.5: Decomposers Unit Posttest (20 min)

- 6.5 Decomposers Unit Posttest
- 6.5 Grading the Decomposers Unit Posttest