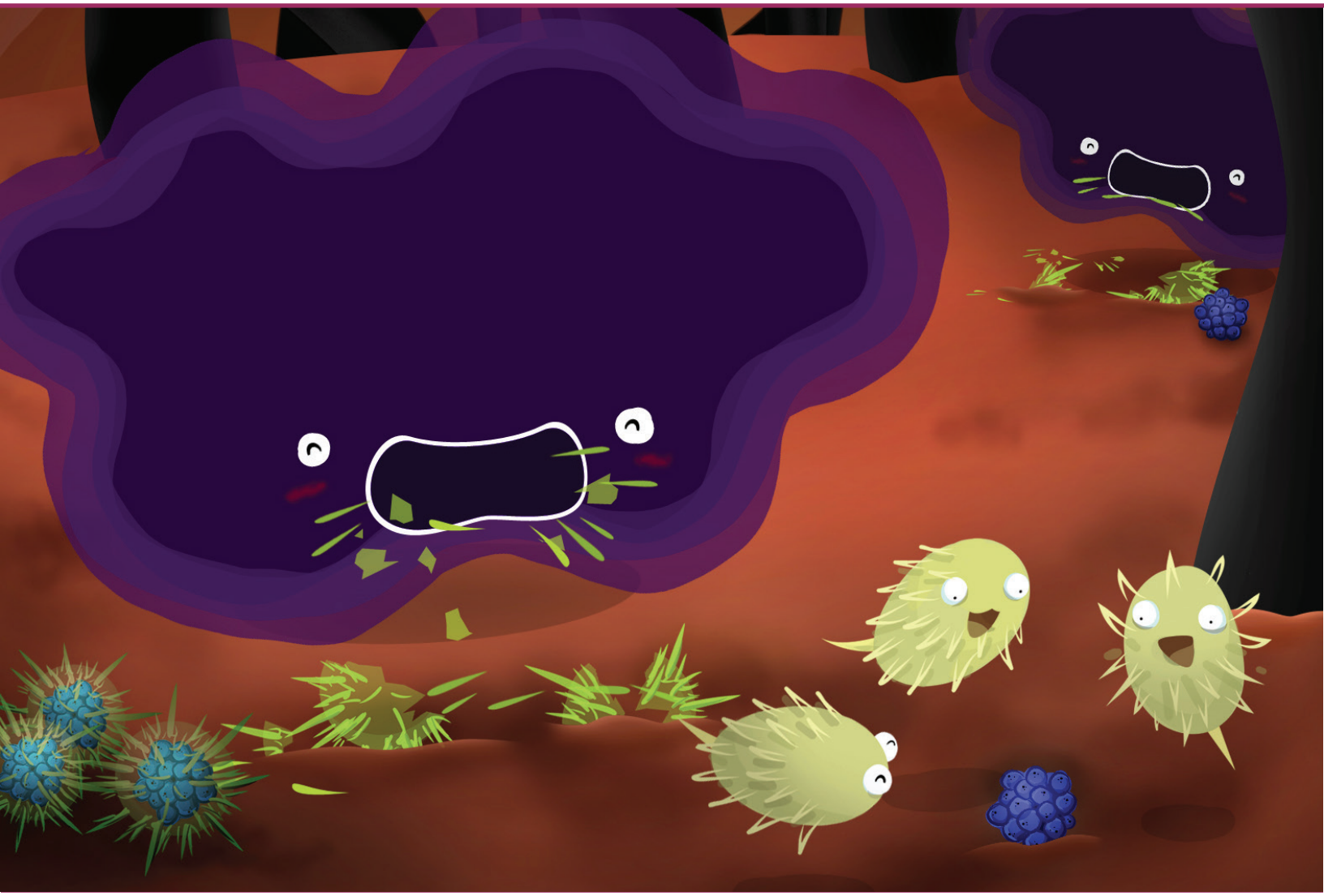
MODULE 3

MAGICAL MICROBES

NGSS TEACHER'S GUIDE

Soil Ecology and Nutrient Cycling



NGSS Alignment

CORE IDEAS

Core Idea LS1: From Molecules to Organisms: Structures and Processes

LS1.A: Structure and Function
LS1.C: Organization for Matter and Energy Flow in Organisms

Core Idea LS2: Ecosystems: Interactions, Energy, and Dynamics

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

Core Idea PS3: Energy

PS3.B: Conservation of Energy and Energy Transfer
PS3.D: Energy in Chemical Processes and Everyday Life

Core Idea ETS1: Engineering Design

ETS1.A: Defining and Delimiting an Engineering Problem
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design Solution

CROSS CUTTING CONCEPTS

- ☐ Patterns
- ☐ Cause and effect: Mechanism and explanation
- ☑ Scale, proportion, and quantity
- ☑ Systems and system models
- ☑ Energy and matter: Flows, cycles, and conservation
- ☑ Structure and function
- ☑ Stability and change

PRACTICES

- ☑ Asking questions (for science) and defining problems (for engineering)
- ☑ Developing and using models
- ☑ Planning and carrying out investigations
- ☑ Analyzing and interpreting data
- ☐ Using mathematics, information and computer technology, and computational thinking
- ☑ Constructing explanations (for science) and designing solutions (for engineering)
- ☑ Engaging in argument from evidence
- ☑ Obtaining, evaluating, and communicating information

Activity 1A: What makes up soil?

Determining Soil Composition

You can find out what type and size particles make up your soil sample with this easy-to-do procedure. This method does not measure the sediment grain sizes directly, but instead relies on something called Stoke's Law, which accurately describes the speed at which particles of different sizes settle, or fall through water. Larger grains sink faster than smaller ones, and clay-size particles sink the slowest. Sand settles in less than a minute, silt in less than an hour and clay in a day.

Time

2 class periods

Materials

- Quart size jar or a 1000 ml beaker
- Ruler with millimeters
- Water
- 0.5 cup (100 ml)
- Small amount of dishwashing liquid (not regular soap)

Procedure: Day 1

1. Obtain a sample of soil
2. Record your observations about its color
3. Smell the soil and record your observations.
4. Touch the soil and make observations about the way it feels between your fingers (is it slippery, gritty, etc.)
5. Fill the jar or beaker mostly full of water
6. Add a few drops of the dish detergent (this helps keep particles separated)
7. Add the soil
8. Shake the jar thoroughly for a full minute or if you don't have a jar with a lid you can stir vigorously for 1 minute.
9. Set the jar or beaker down and leave it for 24 hours.

(continued on next page)

Procedure: Day 2 (after 24 hours settling time)

10. Measure the total thickness (in cm) of the sediment: Measure the thickness of the sediment on the bottom of the container and the thickness of the organic matter, if present, that has floated to the top.
11. This measurement is the total amount of sand, silt and clay and organic matter in the soil. (Note: Be sure the zero mark lines up with the floor inside the jar or beaker.)
12. Shake the jar again and set it down.
13. After 40 seconds, measure the height of the sediment. This is the sand fraction.
14. Leave the jar alone. After 30 minutes, measure the height of the sediment again. This is the sand-plus-silt fraction.
15. With these three measurements, you have all the information needed to calculate the three fractions of your sediment (equation given below)

Data Collection

Table 1. Observations of the soil's color, smell and feel:

Observations	Description
Color:	
Smell:	
Feel of soil:	

Table 2. Measurements and Calculations of layer thicknesses after settling:

Time	Description	Thickness (cm)
24 hours after initial mixing	Thickness of sand, silt and clay settled on bottom of container	
	Thickness of organic material floating on top	
SHAKE JAR again and record measurements below after given times:		

Data Collection (cont.)

Time	Description	Thickness (cm)
40 seconds after second mixing	Amount of Sand	
30 minutes after second shake	Amount of Sand + Silt	
Calculate	Amount of **Silt** = (Sand+Silt) – (sand)	
Calculate	Amount of **Clay** = (Total thickness) – (Sand+Silt thickness)	

Calculate the % of each type of material and record the percentages in Table 3 below:

% sand =	$\frac{\text{sand thickness(cm)} \times 100}{\text{total thickness (cm)}}$
% silt =	$\frac{\text{silt thickness(cm)} \times 100}{\text{total thickness (cm)}}$
% clay =	$\frac{\text{clay thickness(cm)} \times 100}{\text{total thickness (cm)}}$
% organic material =	$\frac{\text{organic material thickness(cm)} \times 100}{\text{total thickness (cm)}}$

Table 3. Soil composition by percentage:

Texture	Percentage (%)
% Sand	
% Silt	
% Clay	
% Organic	

Data Collection (cont.)

Use the percentages of each type of sediment you calculated for your soil sample above and the Soil Texture Pyramid in ***Figure 1*** to find how your soil sample would be classified.

Soil Type	

Table 4. Characteristics of Different Soil Types

Sandy soils	Silty soils	Clay Soils	Loamy Soils
Do not hold water well so can dry out in summer easily	Slightly difficult to drain. Keep water longer than sand	Very water tight, difficult to drain. Can get water logged	Not great drainage
Low in nutrients	Tend to be fertile	Tend to be rich in nutrients	Tend to be rich in nutrients
Warm up quickly in summer	Warm up not as quickly as sandy soils but more quickly than clay soils in summer	Warm up slowly in summer	Consist of sand, silt and clay mixture

Analysis

Compare your results with your classmates.

1. **If you used the same soil as another group, were your results similar? If not try to explain what caused differences in your results.**

2. **If you had different soil samples share results to learn about why different soils have a different look, feel, and smell.**

Analysis (cont.)

Sample	%Sand	% Silt	% Clay	% Organic	Color	Smell	Soil Type
Sample 1 (your soil sample)							
Sample 2							
Sample 3							

3. **Examine the class data. What is the relationship between the color of the soil sample and the texture? Do darker soils contain more sand, silt or clay?**

4. **What is the relationship between the color of the soil sample and the amount of organic material? Do darker soils contain more or less organic material than the lighter colored soils?**

5. The amount of organic matter in soil is an indicator of how fertile the soil is or what the soil's ability is to supply nutrients to the plants and other organisms that live in the soil is. **How fertile do you think your soil sample is? Use your data to support your answer.**

6. **Using the results of this activity explain why different soils have a different look, feel, and smell.**

Activity 1B: What makes up soil?

Determining Soil Composition - An inquiry approach

Have you ever wondered why soils look different in different places? What make one soil darker than another or one soil smellier than another. In this activity you will try to find a way to determine what makes up the different soil samples and try to explain the reason for their different appearances and smells.

Time

2 class periods

Problem

What is in soils that make them look and smell differently?

Claim

Write what you think the reason is that different soils look and smell different.

Introduction

What is Soil?

Soil is a natural substance that is made up of both living and non-living components. The non-living, **inorganic** components consist of small pieces of broken down rock in varying sizes. Sand, silt and clay are the most typical sizes of soil particles but larger sized particles (pebbles and boulders) are occasionally found as well well, as shown in ***Figure 1***.

How much sand, silt, and clay is in the soil determines its **texture**. Soil textures can be classified by the percentage of each type of sediment contained in the soil.

In addition to sand, silt and clay soil contains dark **organic** (living or once living) matter called **humus** which is formed when materials such as dead leaves and dead organisms **decompose**.

Questions to guide your thinking

1. Knowing that soil has many different size sediments (sand, silt and clay), can you think of a way to determine how much of **each type of sediment** your soil sample has?
2. How could you **separate** the different sediment types?
3. How could you determine the **percentage** of each type of sediment in your soil sample?
4. Do you need to record observations about the **color** and **feel** of the soil?
5. **Brainstorm** your ideas with your partner and **test** them to see if they work:
6. After testing your ideas **write a procedure** for determining the percentages of sand, silt and clay in the soil sample.

Procedure

What data will you collect? Draw your data table here:

How will you determine the percent sand, silt and clay form your data? Draw or explain here:

Analysis

Compare your results with your classmates.

1. **How were your methods different and how were they the same?**
2. **Do you think both methods would work equally well? Explain why or why not.**
3. Find a group who used the same soil sample. **Were your results similar? Why or why not?**
4. **If you had different soil samples share results to learn about why different soils have a different look, feel, and smell.**

Sample	%Sand	% Silt	% Clay	% Organic	Color	Smell	Soil Type
Sample 1 (your soil sample)							
Sample 2							
Sample 3							

5. **Examine the class data. What is the relationship between the color of the soil sample and the texture? Do darker soils contain more sand, silt or clay?**
6. **What is the relationship between the color of the soil sample and the amount of organic material? Do darker soils contain more or less organic material than the lighter colored soils?**
7. The amount of organic matter in soil is an indicator of how fertile the soil is or what the soil's ability is to supply nutrients to the plants and other organisms that live in the soil is. **How fertile do you think your soil sample is? Use your data to support your answer.**
8. **Using the results of this activity explain why different soils have a different look, feel, and smell.**