

Soil your undies

Focus questions	How healthy is your soil? What evidence can be used to support the claim of soil health?
Learning target	Students will observe the result of microbial activity on cotton briefs.
Vocabulary	Microbe, abiotic, biotic, macroinvertebrate

MS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics

Performance expectation MS-LS2-3	Classroom connection: Students bury a pair of cotton briefs to determine the amount of microbial activity in the soil.
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Science and engineering practices

Developing and Using Models	Classroom connection: Cotton briefs will act as a food source for microbes.
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Disciplinary core ideas

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems	Classroom connection: Microbes (living organisms) will “eat” the material of the briefs. Based on the number of microbes and macroorganisms in the soil, the briefs will show more or less degradation.
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Cross-cutting concepts

Energy and Matter	Classroom connection: The cotton briefs act as an energy source that is transferred to the microbes to help them do their “work” in the soil.
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Background

The soil ecosystem includes a diverse and large microbiome as well as many macroinvertebrates. These organisms cycle energy through a soil ecosystem that is impacted by many abiotic and biotic inputs: rain, snow, roots, dead organisms, nutrients, additional soil from wind erosion, etc. Sterile, lifeless soil will stain the undies and keep them intact, whereas soil with a thriving biology will eat away at the white undies, leaving nothing but an elastic strap! The greater the biological diversity, the less of the undies there will be.

There are many variations in microbial activity determined by depth and season. This overview by the USDA explains some of these variations. Soil Food Web (nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/biology/?cid=nrcs142p2_053868)

Collecting soil samples and allowing them to warm in the classroom will give students a chance to observe some of the macroorganisms in the soil. See: nrcs.usda.gov/Internet/FSE_MEDIA/nrcs142p2_049822.jpg for a soil food web diagram. Students can identify producers and consumers then look through samples to see if they find examples of each.

Streaking agar plates with sterile swabs that have been immersed in soil or soil solution can be helpful for discovering the amount of bacteria and fungi found in soils.

Materials

- 1 (or more) new pair of white 100% cotton undies (no dyes or polyester blends)
- 1 marker flag
- Shovel
- Gallon storage bag
- Lamotte soil test kit
- Hand lens
- Plastic tub or bucket for soil sample
- Soil Food Web diagram (nrcs.usda.gov/Internet/FSE_MEDIA/nrcs142p2_049822.jpg)
- *Optional:* Agar plates
- *Optional:* Sterile swabs

Prior knowledge

Students should be aware that there are living things in soil that will feed on organic material (cotton).

Teacher preparation

The drawback of this lesson is that it takes 2–3 months to see the results. It is the teacher's choice whether to have pre-planted the briefs or if the students will begin this lesson 2–3 months prior to finishing it.

Choose your planting location carefully. If it is in an area that will be disturbed, the briefs may not be there when you go to find it again. If it is planted over the winter, there may be little activity if the ground is frozen. This can be a great problem-solving activity to share with students. Each student group may choose a different location for their briefs with a reason for choosing it. After collecting the briefs, they can compare and determine which area had the most microbial activity with a supportive statement as to why.

When the briefs are planted, consider having students collect samples that they can examine with hand lenses to look for soil life. They can make a chart that counts the numbers of each of the different organisms they found and they can identify them on the soil food web. When the briefs are collected, they can take another sample to compare to the first soil count.

Use white trays or white dish tubs for soil sample observations. Students can use plastic spoons to move soil around in the tray or tub while looking for macroorganisms. Students must be patient. The soil critters can be elusive and hide well in the soil. If the weather is cold when the soil is collected, it can take a couple of days for soils to warm enough for the critters to become active. If the soil is in an area without many plants, there may be few visible organisms.

Have sterile swabs and petri dishes with agar available for students to use. (Plates can be

Student handout

Reflection

1. What did the undies reveal about the health of the soil? Explain.

The healthier the soil, the more microbial activity there should be. If the briefs are full of holes or barely holding together, the material was found to be a good food source to many microbes and macroinvertebrates.

2. How does the data in the chart above compare to the final state of the undies?

Answers will vary. There may be more nutrients in the soil, illustrating that there was active decomposition of the organic material that returned nutrients to the soil. There may be more critters visible in the soil since there was a food source (briefs) to draw more organisms.

3. What can a farmer do to improve the overall health of the soil?

Add organic material in the form of crop stubble or ground cover during the winter to give microbes a food source. There are other possible answers, such as rotate crops, reduce tillage, or limit the use of broad spectrum insecticides.

Rubric for self-assessment

Skill	Yes	No
I collected data on: soil nutrients,		
...soil activity by macroinvertebrates		
...by streaking soil solution on an agar plate		
...and am able to make a conclusion about microbial and macroinvertebrate activity in the soil.		

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purchased with ready-made agar or you can prepare your own agar.) Have them stick the swab in the soil or a solution of soil and distilled water mixed, then streak on an agar plate. Incubate the plate on the tabletop overnight and colonies will be visible the next day.

Differentiation

Other ways to connect with students with various needs:

- **Local community:** Students may plant the briefs in various locations around the school in a garden area or in a farm field if available.
- **Students with special needs (language/reading/auditory/visual):** Students may watch this video through a VR viewer: youtu.be/-dhdUoK7s2s.
- **Extra support:** Watch this video to see what the results should be: youtu.be/ye9JzFb2eDo.
- **Extensions:** Students compare soils from different areas to see how the activity differs.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Explain the briefs as a model to illustrate soil health.	Student collects data but does not see that the briefs were a food source that helped to measure microbial activity in soil.	Student can explain how the briefs act as a model food source to collect information about microbial life in soil.	Student explains that briefs are a model to measure microbial activity and soil health by describing the energy transfer among organisms in the soil ecosystem.

Rubric for self-assessment

Skill	Yes	No	Unsure
I collected data: on soil nutrients			
...on soil activity by macroinvertebrates			
...by streaking soil solution on an agar plate			
...and am able to make a conclusion about microbial and macroinvertebrate activity in the soil.			