Secrets of Soil

STEAM EDUCATION FOR SUSTAINABLE DEVELOPMENT

PROGRAMME: SEEDING SUSTAINABILITY

MICRO-MODULE 5 SECRETS OF SOIL

CURRICULUM AREAS:

CSPE, English, Geography, Horticulture, Science

Fondúireacht Eolaíochta Éireann
Dá bhfuil romhainn
Science Foundation Ireland
For what's next

An Roinn Oideachais
Department of Education

SDG 15 Seeding Sustainability
Micro-Module 5: Dig Out the Secrets of Soil

Micro-Module (MM) 5: Dig Out the Secrets of Soil

Experimentation and Exploration

Subjects: CSPE, English, Geography, Horticulture, Science

Module Summary: Dig Out the Secrets of Soil

This module provides a comprehensive understanding of the vital relationship between healthy soil and nutritious food. The lessons guide learners through various aspects, starting with an exploration of how balanced nutrition is interconnected with soil health. They then delve into the role of soil in ecosystems and its importance in supporting life and nutrient cycling. Subsequent lessons focus on essential soil nutrients (nitrogen, phosphorus, and potassium), historical developments of soil, current soil issues, and hands-on experiments to measure soil properties and analyse threats like salinisation. The module also covers soil texture, nutrient testing, pH levels, and chromatography, empowering learners to comprehend and appreciate the significance of soil in ecological systems and human life. Through interactive activities and resources, students gain practical knowledge and critical-thinking skills to address soil-related challenges and foster sustainable practices. The module also covers soil texture, nutrient testing, pH levels, and chromatography, empowering learners to comprehend and appreciate the significance of soil in ecological systems and human life.

In this module, the learner will:

- understand the importance of soil for nutrition, health and growing
- understand living organisms within soil
- be exposed to the importance of nitrogen, phosphorus, and potassium in soil
- explore the history of soil
- conduct a number of hands-on experiments
- record and analyse information

Materials

- Lesson plans
- Student worksheets
- Teachers' guides
- Internet access

SDG 15 Seeding Sustainability
Micro-Module 5: Dig Out the Secrets of Soil

NOTE: This module requires access to basic science laboratory equipment and special materials which may need to be purchased. Experiment lessons require preparation by the teacher before the lesson. Please be sure to read all teachers' guides and lesson plans to ensure adequate preparation time is allowed and materials are able to be gathered.

Lesson 1: Healthy Soil Ergo Healthy Food
In this lesson, we will embark on a journey of exploration into the interconnected world of balanced nutrition and soil health. The foods and drinks we consume and the essential nutrients they provide are linked to the nutrients that the soil and the environment can provide to the plants. Through interactive activities and discussions, we will deepen our understanding of what is in our soil and how soil relates to food and nutrition.

Resources: How Dirt Works Worksheet, Soil and Food Worksheet, Teachers' Guide

Lesson 2: Soil and Ecosystems
In this lesson, learners will discover the value of soil as a vital natural resource with various functions such as water regulation, supporting plant and animal life, pollutant filtration, nutrient cycling, and structural support that connect it to its surrounding ecosystems. They will explore different perspectives on the role of the ecosystem around soil to provide plentiful, nutritious and affordable food. This exploration will deepen their understanding of the importance of maintaining good soil in multiple contexts.

Resources: Living Soil Worksheet, Soil Organism Safari Worksheet, Teachers' Guide

Lesson 3: Nitrogen, Phosphorus and Potassium in Soil
In this lesson, students will explore nitrogen, phosphorus and potassium in the soil and their importance for plant nutrition and growth. Learners will be introduced to the nitrogen, phosphorus and potassium cycles and how the enter and exit our soil. Through videos and activities, learners will also explore ways to support soil health in an eco-friendly way.

Resources: Nitrogen Worksheet, Phosphorus Worksheet, Potassium Worksheet, How to Increase Soil Health Worksheet

Lesson 4: Soil Timeline
In this lesson, we aim to understand how soil's historical developments impact today. In this lesson, learners uncover the rich story of soil and its development. Soil is a finite resource, meaning its loss and degradation are not recoverable within a human lifespan. Discussions encourage learners to understand that soils are living ecosystems and not just dirt – soil is a living record of our planet's history that plays a big role in our present and future.

Resources: The Soil Awakens Worksheet, Soil Timeline Worksheet

SDG 15 Seeding Sustainability
Micro-Module 5: Dig Out the Secrets of Soil

Lesson 5: Current Soil Issues
In this lesson, learners explore major soil threats like erosion, salinity, contamination, and more. Learners will begin to understand cause, effect, and solutions, and engage in hands-on activities that stimulate critical thinking to grasp the significance of protecting soils for agriculture, ecosystems, and society.

Resources: Why is Soil Under Threat? Worksheet, Focus on Soil Threats Worksheet

Lesson 6: Salinisation Experiment
In this lesson, we will continue to explore threats to soil. Learners will focus on salinisation and learn about the causes and effects of salinisation through a hands-on experiment.

Resources: Salinisation Experiment Worksheet, Teachers' Guide

Lesson 7: Soil Texture Experiment Preparation
In this lesson, learners will explore how to classify soil based on their physical properties. Learners will learn about soil texture and structure. Then, learners will prepare for a hands-on experiment that will be conducted in the next lesson. This preparation involves collecting soil samples, making observations about their samples and preparing the soil for their experiments.

Resources: Know Your Soil's Texture Worksheet, Soil Texture Experiment Preparation Worksheet, Teachers' Guide

Lesson 8: Soil Texture Experiment
A follow-on from the previous lesson, learners will explore how to classify soil based on their physical properties. Using a hands-on xperiment, learners will be introduced to field work and laboratory work while gaining a deeper understanding of the soil around them.

Resources: Soil Texture Experiment Worksheet, Teachers' Guide

Lesson 9: Soil Nutrient Test
In this lesson, students will explore nitrogen, phosphorus and potassium in soil. Learners will conduct a hands-on experiment to test soil in their area. Note: This lesson requires the purchase of a soil test kit (see Teachers' Guide).

Resources: Soil Test Worksheet, Teachers' Guide

Lesson 10: Soil pH Experiment
In this lesson, learners explore the significance of soil pH in plant growth through active listening and hands-on activities. They will delve into pH as a measure of acidity or alkalinity, emphasising its crucial role in soils and agriculture. By understanding plants' ideal pH ranges, acid rain's effects,

and nutrient solubility, various practical aspects unfold. The experiment to measure soil pH fosters analytical skills and teamwork. The lesson equips learners with theoretical knowledge and practical know-how, enabling them to comprehend and apply the importance of pH for plant growth.

Resources: Soil pH Worksheet, Teachers' Guide

Lesson 11: Soil Chromatography Preparation
In this lesson, we delve into the world of soil analysis, shedding light on the critical role soil plays as a natural resource for both human health and ecosystems. We will get acquainted with the techniques needed and prepare to explore soil components and its interactions, through a paper chromatography experiment. This lesson focuses on providing an introduction to chromatography as well as serving to prepare all the materials needed for the hands-on experiment.

Resources: Chromatography Preparation Worksheet, Teachers' Guide

Lesson 12: Soil Chromatography Experiment
In this lesson, we look at the intriguing world of chromas, captivating and intricate images that unveil the hidden beauty and complexity of soil composition. This method allows us to capture a soil sample's essence on paper, creating unique pieces of art that reflect the soil's composition and the bustling microcosm within it.

Resources: Chromatography Worksheet

Using the Resources:
If you wish to use these resources, we can offer an induction and online support throughout the unit. To register for this option, please contact Rebecca White, e: rebecca.white@ucd.ie

Module development and expertise: Dr. Rodrigo Pérez García, Polyhedra.eu Co-founder and Inova DE GmbH Innovation Officer and Dr. Jessica Garska, University College Dublin

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Articles

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- Rosén, A.P. (2022) 'Relating to soil: Chromatography as a tool for environmental engagement', Designing Interactive Systems Conference (pp. 1640-1653). Available at: https://dl.acm.org/doi/pdf/10.1145/3532106.3533503

Websites

- Clemson Cooperative Extension. (2022). Soil Texture Analysis "The Jar Test". Clemson University: College of Agriculture, Forestry and Life Sciences. Available at: https://hgic.clemson.edu/factsheet/soil-texture-analysis-the-jar-test/
- ESY Berkeley Teaching Staff. (n.d.). Soil pH Lab. The Edible Schoolyard Project. Available at: https://edibleschoolyard.org/resource/soil-ph-lab
- European Commission. (n.d.). EU Soil Observatory: EUSO Soil Health Dashboard. European Commission. Available at: https://esdac.jrc.ec.europa.eu/esdacviewer/euso-dashboard/
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MM5 SEEDING SUSTAINABILITY: DIG OUT THE SECRETS OF SOIL REFERENCE LIST

Documents

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Videos

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- Clean Food Living. (2023) Calibrate a pH Meter (Step by Step) + How to Use pH Meter. Available at: https://www.youtube.com/watch?v=2ZmSBKKINEc&ab_channel=CleanFoodLiving
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MM5 SEEDING SUSTAINABILITY: DIG OUT THE SECRETS OF SOIL REFERENCE LIST

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MM5 SEEDING SUSTAINABILITY: DIG OUT THE SECRETS OF SOIL REFERENCE LIST

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PowerPoints

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Images

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SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 1: Healthy Soil, Ergo Nutritious Food

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Healthy Soil, Ergo Nutritious Food

In this lesson, we will embark on a journey of exploration into the interconnected world of balanced nutrition and soil health. The foods and drinks we consume and the essential nutrients they provide are linked to the nutrients the soil and the environment can provide to the plants. Through interactive activities and discussions, we will deepen our understanding of what is in our soil and how soil relates to food and nutrition.

Vocabulary: Soil Health, Nutrients, Crops, Sustainable, Environment, Agent of Change

In this lesson, the learner will:

- understand how soil health is crucial for growing nutrient-rich crops.
- develop an awareness of how healthy and nutritious food is essential for overall well-being.
- understand how nutrient deficiencies in the diet can have negative consequences on health.
- explore how Individuals can make a positive impact on food justice in their communities and become agents of change

Materials:

- Worksheet: How Dirt Works
- Worksheet: Soil and Food
- Teachers' Guide
- Projector
- Internet access

MM5: Dig Out the Secrets of Soil
L1: Healthy Soil, Ergo Nutritious Food

ACTIVITY INSTRUCTIONS

Activity 1: Active Listening (20 minutes)

1. Challenge learners to name a product (food, materials, and any objects you see in the classroom) that was not produced or somehow supported by soil.
2. Watch the video: How Dirt Works (4:27min).
3. Have learners complete Worksheet: How Dirt Works as they are watching the video.
4. Have learners compare their answers after the video.
5. Discuss as a class.

Activity 2: Soil and Food (30 minutes)

1. Watch the video Story of Soil and Food (4:46min).
2. Have learners complete the worksheet: Soil and Food Part 1.
3. Briefly discuss as a class.
4. Divide the learners into groups of 2 or 3. Have learners complete the rest of the worksheet.
5. Discuss as a class.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L1: Healthy Soil, Ergo Nutritious Food

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, remove Activity 1.

Extension: For a longer class, ask the learners to share their favourite fruit or vegetable of each colour of the rainbow. After each student shares their choices, ask them to visit: https://www.health.harvard.edu/blog/phytonutrients-paint-your-plate-with-the-colors-of-the-rainbow-2019042516501 to learn about the phytonutrients of different coloured plants.

Encourage students to think about the vibrant colours they see in their favourite foods or in the fields and connect them to specific nutrients to prepare a perfect rainbow meal.

If time allows, ask them to draw or illustrate a healthy meal.

MEDIA BOX (materials, online video links, extra resources, case studies etc)

How Dirt Works [4:27 min] https://vimeo.com/77792712

Story of Soil and Food [4:46 min] https://www.youtube.com/watch?v=uIW-aYHE60k&ab_channel=SoilLife

Healthy Soils Are the Basis for Healthy Food Production https://www.fao.org/3/i4405e/I4405E.pdf

Soils Need Nutrients Too -Web PowerPoint https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.soils.org%2Ffiles%2Flessons%2Fteachersguide%2Fsoils-nutrients.pptx&wdOrigin=BROWSELINK

Phytonutrients: Paint Your Plate With the Colours of the Rainbow: https://www.health.harvard.edu/blog/phytonutrients-paint-your-plate-with-the-colors-of-the-rainbow-2019042516501

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Ask a medical doctor about your favourite fruit and what it does to your health.

Ask a farmer what they do to keep soil healthy. Ask them about the diversity of crops in the past and present.

L1: HOW DIRT WORKS

Answer the following questions:

What do you think about the product you said was not produced by soil? Was it produced by soil? If so, how?

What is soil?

What would we not have without soil?

What does soil provide?

What do they say about decomposition?

What lives in the soil?

What are micro-organisms (you may use google to help!)?

How do they describe the food web?

L1: HOW DIRT WORKS

What does soil do to water, air and nutrients?

Why did they use the Dust Bowl as an example?

Do you think you can make soil in a laboratory? why?

What can we do to help soil?

L1: SOIL AND FOOD

Part 1

While watching the video, answer the following questions:

What do plants take from the air?

What do plants take from the soil?

What percentage of our body is 'soil'?

How many elements does soil provide for our body? Give some examples and what they do for our body.

How do those elements reach us (e.g. through plants)?

What percentage of food we eat can be traced back to soil?

What changed in around 11,000 BC?

L1: SOIL AND FOOD

Why are different soils linked to growing different types of crops?

What are some of the unintended consequences of shipping food around the world?

What happens to nutrients when we harvest food?

Why are nutrients not being added back to the soil from food waste?

What happened to the diversity of crops?

What are some examples of soil degrading?

What are some current challenges of growing food?

What are some solutions to these challenges that people have been doing recently?

L1: SOIL AND FOOD

What lives in the soil? Why are they important?

_____

_____

_____

What percentage of soil microbes have we identified?

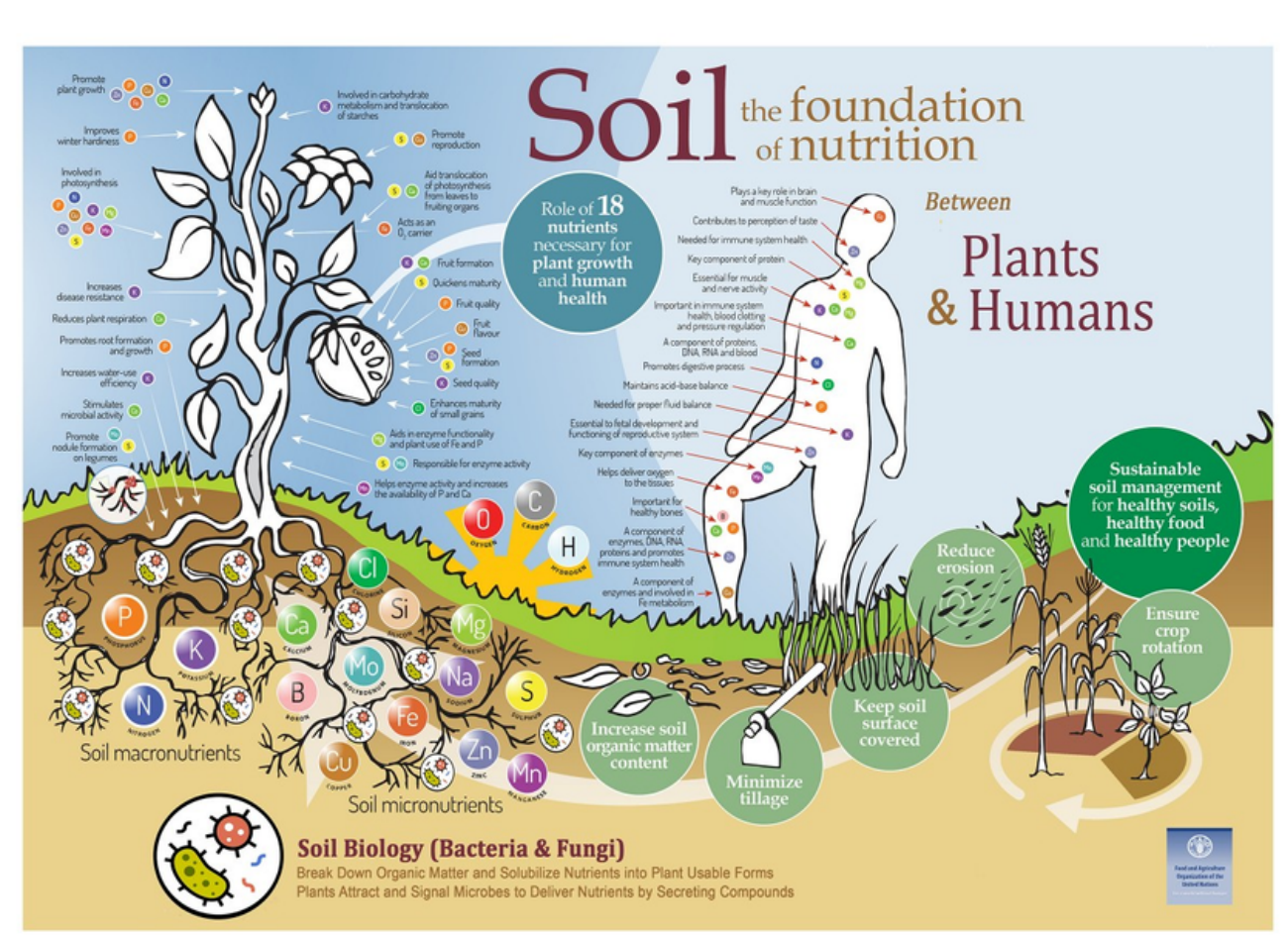
_____

_____

_____

Part 2

Now, look at the photo below and answer the questions that follow.



https://naturcycle.com/wp-content/uploads/2019/03/Body-Image-200dpi-1200x900.jpg

L1: SOIL AND FOOD

Look carefully at the image in this worksheet and with all other information you have, answer the following questions in complete sentences

Why is it important for everyone to have access to healthy and nutritious food?

How does the health of the soil affect the nutrient content of fruits and vegetables?

Why is it important to have nutrient-rich foods in our diet?

What are some consequences of nutrient deficiencies in our diet?

How does the composition of soil impact the nutrients found in the plants it supports?

Can you identify two specific nutrients that are crucial for plant growth? Why are these nutrients important? Why did you choose these particular nutrients?

Think about how these nutrients are absorbed by plants. What role does soil play in this process?

L1: SOIL AND FOOD

Consider the human aspect. How might the nutrients in the plants we consume benefit our health? How might these nutrients impact human health when we consume plants rich in them?

L1: TEACHERS' GUIDE

Activity1:

Products like smartphones, cutlery, and paper might not be linked to soil directly, but the raw materials used in manufacturing these come from the Earth's resources usually coming from soil.

Soil is the upper layer of the Earth's crust that consists of mineral particles, organic matter, water, air and living organisms.

It's a natural resource that plays a critical role in supporting plant growth, which in turn sustains human and animal life. Soil provides essential nutrients and support to plants and serves as a foundation for agriculture and food production. Additionally, soil serves as a habitat for various organisms, helps to filter and purify water, regulates water flow and drainage, and also stores carbon. It's vital for maintaining ecosystems, supporting biodiversity, and ultimately providing the basis for life on our planet.

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Experimentation and Exploration

Lesson 2: Soil and Ecosystems

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil and Ecosystems

In this lesson, learners will discover the value of soil as a vital natural resource with various functions such as water regulation, supporting plant and animal life, pollutant filtration, nutrient cycling, and structural support that connect it to its surrounding ecosystems. They will explore different perspectives on the role of the ecosystem around soil to provide plentiful, nutritious and affordable food. This exploration will deepen their understanding of the importance of maintaining good soil in multiple contexts.

Vocabulary: Abiotic, Biotic, Ecosystems, Fertility, Humus, Symbiotic, Tardigrade

In this lesson, the learner will:

- understand that soil is a crucial natural resource that serves essential functions
- realise that soil health directly impacts the health of surrounding ecosystems and vice versa
- grasp the interactions between living organisms and non-living factors like minerals and climate
- understand the process of decomposition, necessary for plant growth

Materials:

- Worksheet: Living Soil
- Worksheet: Soil Organism Safari
- Teachers' Guide
- Magnifying glass
- Jars and shovels for each group
- Tweezers (for handling samples)
- White sheets of paper
- Water
- Optional: microscope, slides and coverslips (for making microscope slides)

MM5: Dig Out the Secrets of Soil
L2: Soil and Ecosystems

ACTIVITY INSTRUCTIONS

Activity 1: Active Listening (10 minutes)

1. Watch the video The Living Soil Beneath Our Feet | California Academy of Sciences - YouTube (2:50min).
2. After watching the video, have learners answer the true and false questions on Worksheet: Living Soil.
3. Discuss as a class.

Activity 2: Soil Organism Safari (40 minutes)

1. Learners will collect soil samples and look at the organisms inside of the soil. Limit soil collection time to 15 minutes.
2. Have learners follow the worksheet: Soil Organism Safari. See Teachers' Guide.

NOTE: You may choose to use a microscope; see teachers' guide for instructions.

3. Discuss their results as a class. Use these questions to encourage discussion:
   a. Do you know what the organisms are named?
   b. Do they have legs?
   c. What do they eat?
   d. What eats them?
   e. Did you also find organic matter (e.g. leaves)?
   f. Did you find silt, clay, sand, and rock fragments?

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L2: Soil and Ecosystems

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, prepare soil samples before the class so learners do not need to prepare the samples themselves.

Extension: For a longer class, prepare microscope slides with the learners so they can have a closer look at their soil samples using a microscope (see Teacher's Notes).

Option B: Ask learners if soil may mean something different for each of us. Start with the example and let them answer the rest. What does soil mean to . . .

1. A construction worker? Soil is a building material for construction
2. A farmer?
3. A geologist?
4. An earthworm?
5. A fish?
6. A tree?
7. You?

Discuss why these answers are different (or similar)?

MEDIA BOX (materials, online video links, extra resources, case studies etc)

The Living Soil Beneath Our Feet | California Academy of Sciences - YouTube [2:50 min] https://www.youtube.com/watch?v=MlREaT9hFCw

Healthy Soils are the Basis for Healthy Food Production https://www.fao.org/3/i4405e/I4405E.pdf

Why soil is one of the most amazing things on Earth | BBC Ideas [4:40min] https://www.youtube.com/watch?v=OiLITHMVcRw

The Apple as Planet Earth [2:43min] https://www.youtube.com/watch?v=mA78nPn41F4

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Have learners collect soil samples from areas around town or from a farm. What do they see?

Ask a local farmer or grower what kinds of organisms they like to see in their soil. What kinds of organisms do they not like to see in their soil? Do they intentionally add any organisms to their soil? Why or why not?

L2: LIVING SOIL

After you watch the video, decide if the following statements are true or false:

1. Billions of organisms inhabit the upper layers of the soil, breaking down dead organic matter and releasing nutrients for plant growth.

2. The science that describes interactions among living and nonliving factors in the soil environment is soil ecology.

3. The two main types of organic matter found in soil are living organic matter and humus.

4. The process by which soil organisms “eat” organic matter and release nutrients into the soil is called recycling.

5. Soil structure refers to the arrangement of soil particles into aggregates of different sizes and shapes and soil composition to the different constituents (sand, lime, clay, humus).

6. Having a good soil structure allows water infiltration, provides spaces for air and roots, but it has no effect on habitats for soil organisms.

7. Mycorrhiza is a term used to describe the symbiotic relationship between some plants and fungi, where fungi help plants absorb water and nutrients in exchange for their food.

8. A diverse plant community in soil ecosystems can increase nutrient cycling, improve soil stability, and reduce pest and disease incidence.

9. Carbon sequestration is a natural process by which soil organisms store carbon in the soil, reducing greenhouse gas emissions and mitigating climate change.

10. Soil Management practices, such as crop rotation, cover cropping, agroforestry, and soil conservation techniques, can protect and restore soil ecosystems.

L2: SOIL ORGANISM SAFARI

You are going to go on a soil organism safari! First you will need to collect a soil sample. Your teacher will tell you which areas you are allowed to collect soil from, and will give you a time limit to be back in the classroom with your soil sample.

Group name: _____

STEP 1:
Collect at least 1 soil sample (a coffee cup equivalent of volume) with your hands or a small shovel. Each group should collect samples from different areas and should be taken from a depth of 5 to 10 cm under the ground. Please make sure there is no rubbish in your soil sample.

STEP 2:
Place the soil in a jar you can close and label the jar with: your group name, the location and collection date.

Bring your soil sample in the jar back to the classroom.

Next, look at the soil with your naked eye and answer the following questions:

What do you see?

_____
_____
_____

What is the colour of your soil?

_____
_____
_____

What do you expect to find in your soil samples?

_____
_____
_____

Are there any organisms in the soil? If so, write down what you see:

_____
_____
_____

L2: SOIL ORGANISM SAFARI

Are there any silt, clay, sand, and rock fragments? If so, write down what you see:

_____

_____

_____

STEP 3:
You are now going to take a closer look at your soil sample. Spread a teaspoon of your soil sample on a white piece of paper. Use the magnifying glass to explore your soil sample.

What do you see?

_____

_____

_____

Are there any organisms in the soil? If so, write down what you see:

_____

_____

_____

Are there any silt, clay, sand, and rock fragments? If so, write down what you see:

_____

_____

_____

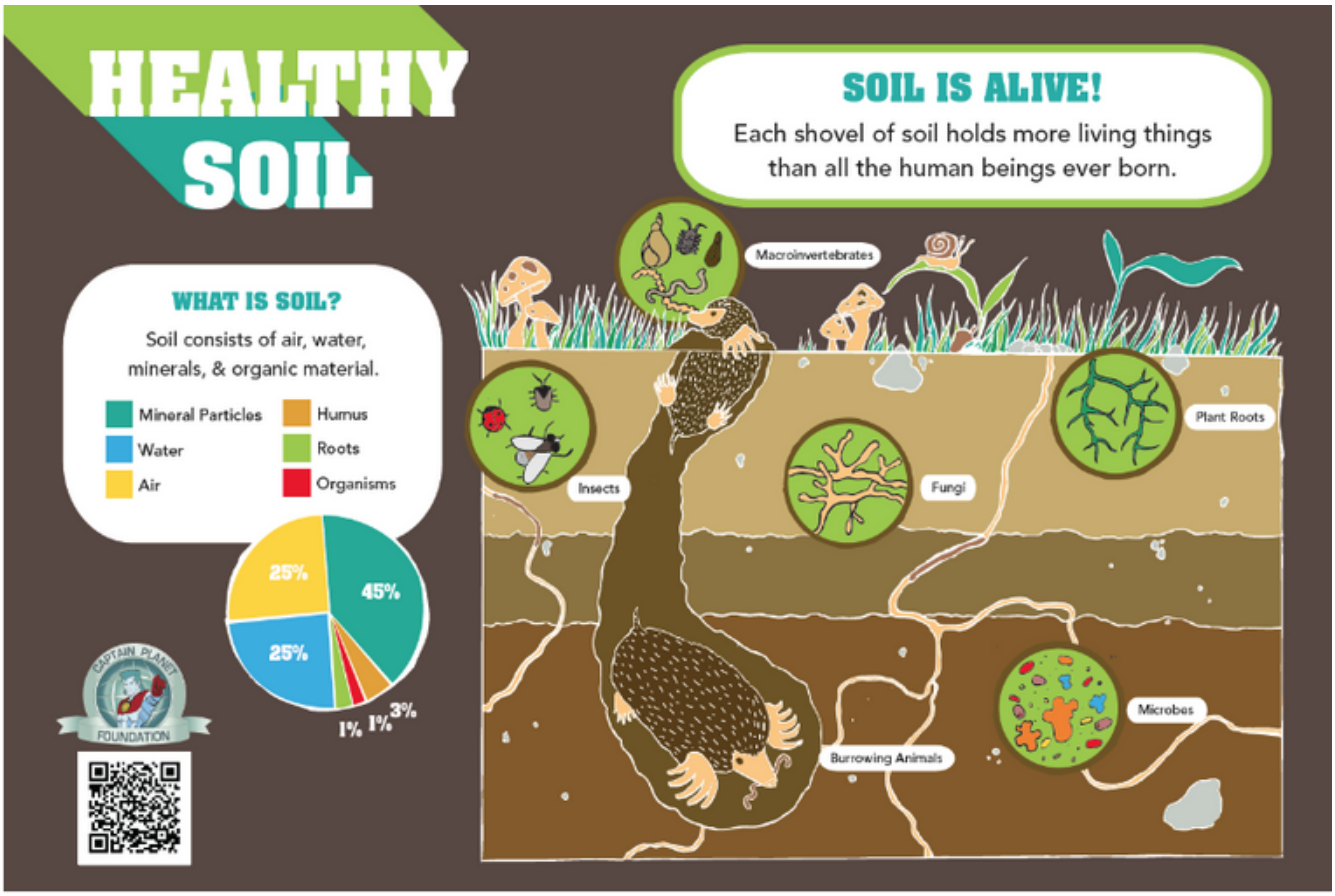
STEP 4:
Write the results in the table:

Sample	Colour	Sample Location	Date	Organisms I think are present

*The colour indicates the amount of organic matter (humus), for example leaves. The soil will be darker if there is more organic matter inside.

L2: SOIL ORGANISM SAFARI

Look at the following picture and answer the questions below:



From captainplanetfoundation.org

How does your soil sample compare with the photo? Do you see some of the same organisms in your soil as in the photo? If so, name them.

Did your initial guess of what you expected to see in your soil and the final analysis differ a lot? Why or why not?

L2: SOIL ORGANISM SAFARI

Could you identify all the following constituents of the mineral components of soil: silt, clay, sand, and rock fragments? Name those you found in your sample.

Brainstorm the characteristics of 2-3 organisms you found, and their possible role in the soil ecosystem.

L2: TEACHERS' GUIDE

Answer sheet for Activity 1:

1. True
2. True
3. True
4. False
5. True
6. False
7. False
8. True
9. True
10. True

Activity 2:

Before class preparation:

Distribute the necessary materials for each group (magnifying glass, tweezers, jar, shovel). If you are going to use the microscope, make sure the microscopes are in the classroom and ready to use. Have microscope slides on hand. You will need to explain how to use each tool safely and effectively.

Collecting soil samples:

Have learners collect soil samples, or in the case of weather conditions or time, have enough soil samples already collected for each group to observe and use two soil samples. If you collect the soil samples they are using, you will need to give them the location you collected them from.

Give learners boundaries for collecting their samples (e.g. they cannot leave school grounds, certain areas are off-limits - e.g. flower beds around the school, they can go to the beach or park nearby if within walking distance.

NOTE: Be sure to seek approval to collect soil samples from any location you send the learners to before the lessons so learners know exactly where it is OK and not OK to take soil samples from. Set a time limit for them to collect samples.

During analysis:

You may consider preparing your own samples so you can project images to guide them in identifying the different organisms present.

L2: TEACHERS' GUIDE

Monitor the analysis as learners may need help spreading their sample or looking for organisms.

If you are going to use microscopes, you will need to make wet mount microscope slides. For this you will need:

Slides
Coverslips
Toothpicks
Water
Scissors
Forceps (optional)
Razor Blade
Microscope

1. Place a small drop of water on a clean slide.
2. Use a toothpick or forceps to gather the soil.
3. Transfer the soil to the water by touching the toothpick or forceps to the water. If necessary, gently move the toothpick or forceps to dislodge materials.
4. Carefully lower a coverslip onto the slide.
5. Examine the slide under low and high power of the microscope.

This section of the Teacher's Notes is to help support you with Activity 2 by giving background information on what can be found.

1. Bacteria:
   - Characteristics: Bacteria are tiny single-celled microorganisms that are abundant in soil. They come in various shapes, including spheres, rods, and spirals.
   - Role: Bacteria are key decomposers in the soil ecosystem. They break down complex organic matter into simpler compounds, releasing essential nutrients like nitrogen, phosphorus, and carbon. These nutrients become available for plants to absorb and use for growth.
2. Fungi:
   - Characteristics: Fungi are diverse and range from microscopic to larger visible structures like mushrooms. They have thread-like structures called hyphae and can form intricate networks known as mycelium.
   - Role: Fungi play a critical role in breaking down tougher organic materials, such as cellulose and lignin. They form symbiotic relationships with plants, known as mycorrhiza, where they help plants absorb water and nutrients, and in turn, receive carbohydrates from the plants. Fungi also aid in soil improvement.

3. Earthworms:
    - Characteristics: Earthworms are larger, visible organisms with segmented bodies. They have a distinct role in soil health.
    - Role: Earthworms are excellent soil mixers. As they burrow through the soil, they create channels that allow water, air, and plant roots to move freely. Their burrows also facilitate the decomposition process by providing pathways for microorganisms to access organic matter. Earthworm castings are nutrient-rich and contribute to soil fertility.
4. Arthropods:
    - Characteristics: Arthropods include insects, spiders, mites, and ants. They have exoskeletons and jointed legs.
    - Role: Arthropods contribute to soil aeration and nutrient cycling. Some arthropods, like beetles and ants, aid in organic matter breakdown and help distribute nutrients. Predatory arthropods keep pest populations in check, promoting a balanced ecosystem. Mites and springtails assist in decomposition by feeding on microorganisms and dead organic matter.

SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 3: Nitrogen, Phosphorus and Potassium in Soil

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Nitrogen, Phosphorus and Potassium in Soil

In this lesson, students will explore nitrogen, phosphorus and potassium in the soil and their importance for plant nutrition and growth. Learners will be introduced to the nitrogen, phosphorus and potassium cycles and how the enter and exit our soil. Through videos and activities, learners will also explore ways to support soil health in an eco-friendly way.

Vocabulary: Nitrogen, Phosphorus, Potassium, Leaching, Nitrogen Fixers

In this lesson, the learner will:

- discover the importance of Nitrogen, Phosphorus and Potassium in soil
- explore ways to support soil health in an eco-friendly way
- develop teamwork, active listening and communication skills

Materials:

- Worksheet: Nitrogen
- Worksheet: Phosphorus
- Worksheet: Potassium
- Worksheet: How to Increase Soil Health
- Internet access

MM5: Dig Out the Secrets of Soil
L3: Nitrogen, Phosphorus and Potassium in Soil

ACTIVITY INSTRUCTIONS

Activity 1: Nitrogen (10 minutes)

1. Watch the video Understanding Our Soil: The Nitrogen Cycle, Fixers, and Fertilizer [4:29 min]
2. Have learners complete the worksheet: Nitrogen
3. Discuss as a class

Activity 2: Phosphorus (7 minutes)

1. Watch the video Phosphorus Cycle [2:47min]
2. Have learners complete the worksheet: Phosphorus
3. Discuss as a class

Activity 3: Potassium (5 minutes)

1. Watch the video Potassium in Plant Health [1:44min]
2. Have learners complete the worksheet: Potassium
3. Discuss as a class

Activity 4: How to Increase Soil Health (28 minutes)

1. Divide the class into groups.
2. Assign each group either Nitrogen, Phosphorus or Potassium
3. In their groups, have learners complete the worksheet: How to increase soil health.
4. Have each group share their answers.

NOTE: Learners will conduct an experiment on the amount of nitrogen, phosphorus and potassium in soil in lesson 9. It may be beneficial to keep their worksheets from this class to refer to in Lesson 9.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L3: Nitrogen, Phosphorus and Potassium in Soil

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, have learners watch the videos at home and discuss in class.

Extension: For a longer class, have learners watch the additional videos. Have learners create and present a poster for Activity 4. See Media Communication module: Posters.

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Understanding Our Soil: The Nitrogen Cycle, Fixers, and Fertilizer [4:29 min]
https://www.youtube.com/watch?v=A8qTRBc8Bws&ab_channel=JimiSol

Free Organic Nitrogen Sources For Plants And Garden! Our Top 10! [10:54]
https://www.youtube.com/watch?v=xJqkXK3htyY&ab_channel=CountryLivingExperience%3AAHomesteadingJourney

Is there enough phosphorus in your soil? | DIY garden projects | Gardening Australia [5:02 min]
https://www.youtube.com/watch?v=_DPPNQsUvgs&ab_channel=GardeningAustralia

Phosphorus Cycle
[2:47min] https://www.youtube.com/watch?v=izgqpfPZyRQ&ab_channel=MooMooMathandScience

Potassium in Plant Health [1:44 min] https://www.youtube.com/watch?v=86Xb8Wf3qX4&ab_channel=CropNutritionfromTheMosaicCompany

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

If you plan to deliver Lesson 9, which is an experiment testing the soil for nitrogen, phosphorus and potassium, you will need to buy a soil test kit. Some suggested test kits:

- Up to 60 soil samples using test tubes and reagent: https://www.quickcrop.ie/product/super-soil-test-kit-60-tests
- Up to 8 soil samples using an integrated control / test tube chamber (additional test tubes will be needed if you choose this test kit as each test will need to sit for 10 minutes): https://www.thegardenshop.ie/soil-test-kit/

Speak to local farmers and growers about what nutrients are deficient in your area.
Speak to a local farmer about how they make sure they have enough nitrogen, phosphorus and potassium in their soil. Now, talk to an organic gardener about how they make sure they have enough nitrogen, phosphorus and potassium in their soil. How do they compare?

L3: NITROGEN

Answer the following questions as you watch the video:

What are some examples of nitrogen fixers?

What do they do?

Why do plants need nitrogen?

Why is nitrogen fertiliser possibly not as good as using nitrogen fixers?

What role does bacteria play in the nitrogen cycle?

What forms of nitrogen are available to plants?

What do plants most often rely on to take up nitrogen?

What role do worms play in the nitrogen cycle?

L3: NITROGEN

How does nitrogen leave soil?

Does nitrogen leave the soil if it is in organisms? Why could this be important?

How do nitrogen fixing plants relate to bacteria?

What is the trouble with fertilisers?

What other minerals do the fungi bring to plants?

L3: PHOSPHORUS

Answer the following questions as you watch the video:

What does phosphorus do for our bodies?

What does phosphorus do for plants?

What type of is phosphorus encountered in the world?

Where are phosphate compounds found?

How does phosphorus leach into the soils?

What are two other sources of phosphorus?

How do phosphates re-enter the soil after being taken up by plants or animals?

How are they carried to lakes, rivers and oceans?

L3: PHOSPHORUS

What organism in bodies of water take up phosphorus?

Why is the phosphorus cycle very slow?

Why are phosphorus fertilisers potentially damaging to water ecosystems?

What are dead zones? How are they formed?

L3: POTASSIUM

Answer the following questions as you watch the video:

Is potassium mobile in soil? Why or why not?

What is the cation exchange capacity?

How do plants take up potassium?

What does potassium do for plants?

What types of stress does potassium help plants withstand?

L3: HOW TO INCREASE SOIL HEALTH

Group name:

Circle what nutrient you are researching: nitrogen phosphorus potassium

You will need to use the internet to research the following questions about your nutrient. Be sure to manage your time well and allocate roles to your team (e.g. note-taker, researcher, time keeper, etc.).

Explain the role of your nutrient in the growth and development of plants.

How does your nutrient interact and affect the other two nutrients?

What are some symptoms of a deficiency of your nutrient in plants?

What happens if there is too much of your nutrient in the soil?

What are two consequences of excessive use of fertilisers on the environment and ecosystems.

L3: HOW TO INCREASE SOIL HEALTH

What are three ways you can increase the amount of your nutrient in the soil organically / naturally (e.g. not using synthetic fertilisers)?

Do you think farmers and growers in your area struggle with a deficiency of your nutrient in their soil? Why or why not?

SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 4: Soil Timeline

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil Timeline

In this lesson, we aim to understand how soil's historical developments impact today. In this lesson, learners uncover the rich story of soil and its development. Soil is a finite resource, meaning its loss and degradation are not recoverable within a human lifespan. Discussions encourage learners to understand that soils are living ecosystems and not just dirt – soil is a living record of our planet's past that plays a big role in our present and future.

Vocabulary: Biochemical Synthesis, Molten State, Stratified Growth, Weathering

In this lesson, the learner will:

- realise that soils are like living characters that change and evolve
- appreciate that soil is a precious resource, vital for food, water, and biodiversity, crucial for a sustainable future.
- understand how soils formed in different time periods and how this affects our landscapes today.

Materials:

- Worksheet: The Soil Awakens
- Worksheet: Soil Timeline
- Internet access

MM5: Dig Out the Secrets of Soil
L4: Soil Timeline

ACTIVITY INSTRUCTIONS

Activity 1: Active Listening (20 minutes)

1. Watch the video: The Soil Awakens: The Story of Soil Life (7:27min).
2. Have the learners complete Worksheet: The Soil Awakens
3. Discuss as a class.

Activity 2: Soil Timeline (30 minutes)

1. Divide learners into groups of four or five.
2. Assign each group a geological time period and have learners choose which aspect they will research: Landscape, Plants, Animals, Atmosphere, and Other Geological Features.
3. Learners are tasked with finding an image to represent each aspect of their time period along with a few interesting facts. Have learners complete the worksheet: Soil Timeline.
4. Draw a horizontal line across the board. This is your timeline.
5. Have each group present their findings (e.g. through a few slides, or showing the images and talking about the images) along with writing their geological time period on the timeline on the board.
6. After each group has presented, facilitate a class discussion using the following questions:
    a. What are some important changes that took place over the Earth's lifespan?
    b. What did they find most interesting and why?
    c. Why is it important to protect and conserve soil for the future?

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L4: Soil Timeline

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, skip Activity 1 or have learners present their findings in Activity 2 on a shared drive or in the next lesson.

Extension: For a longer class, ask learners to reflect on the significance of soil formation history for land use, agriculture, and environmental management. For instance, asking the following (they may need to use Google to help them come up with answers):

1. Imagine you're planning a small garden in your backyard. How might knowing about the history of soil formation in your area help you decide what plants to grow? What are the key differences in soil characteristics between a garden and a forest, or a current building area? Or,
2. Think about a local park or nature reserve. How could understanding the history of soil formation in that area help park managers take better care of the land and the wildlife? Are there periods with more diverse ecosystems than others in these? Why might this be?

MEDIA BOX (materials, online video links, extra resources, case studies etc)

The Soil Awakens: The Story of Soil Life [7:27min] youtube.com/watch?v=_ZRw6ZzY3Dk

What Are Soils? https://www.nature.com/scitable/knowledge/library/what-are-soils-67647639/

A Brief History of Geologic Time [12:08min] https://www.youtube.com/watch?v=rWp5ZpJAIAE

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Find one real-world example, preferably near your home, where knowledge of soil history has influenced a specific land use or its particular orography. Briefly describe the situation and its outcome.

See if you have any rock formations or exposed areas of soil where you can observe different soil horizons.

L4: THE SOIL AWAKENS

Answer the following questions as you watch the video:

Name the scientific theory that explains how the universe came into existence, leading to the formation of stars, planets, and galaxies.

Describe 3 reasons why Earth is suitable for life.

What happened to Earth after it's early 'wild days' which helped life evolve on Earth?

How did soil form?

What happened to the nutrients in the newly formed soil?

How did microorganisms play a big role in creating important building blocks like carbon, nitrogen, hydrogen, and oxygen?

How is soil a recycling system?

L4: THE SOIL AWAKENS

What are soil horizons? How were they formed? Why are they important?

What does soil do for the Earth?

What did humans do to the soil? How is it changing now?

L4: SOIL TIMELINE

You are going to research the geological timeline of Earth.

Your teacher will assign each group a time period, and each person in the group will need to find different images for that time period:

Landscape:
Plants:
Atmosphere:
Animals:
Other geological features (e.g. volcanoes, etc.):

This can be a good reference: https://www.gsi.ie/en-ie/education/our-planet-earth/Pages/Geological-Time.aspx

Geological Period	Years Ago	Duration in Years
Precambrian	4.6 billion - 541 million	4.06 billion
Paleozoic	541 million - 252 million	289 million
Mesozoic	252 million - 66 million	186 million
Cenozoic	66 million - present	Still Continuing

What geological period and aspect had you been assigned?

_____

Why did you choose your image? What caught your attention and why?

_____

_____

_____

L4: SOIL TIMELINE

What does the picture represent?

Show your image to your group. What similarities and differences do your images have?

Why do you think these different features are important for your time period?

Write a small description of interested information and facts you found associated with your image and time period:

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MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 5: Current Soil Issues

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Current Soil Issues

In this lesson, learners explore major soil threats like erosion, salinity, contamination, and more. Learners will begin to understand their causes, effects, and solutions, and engage in hands-on activities that stimulate critical thinking to grasp the significance of protecting soils for agriculture, ecosystems, and society.

Vocabulary: Erosion, Organic Matter Decline, Compaction, Salinisation, Contamination, Biodiversity Loss

In this lesson, the learner will:

- recognize and define the major soil threats.
- explain the causes, effects, and mechanisms behind each soil threat.
- understand how some human activities and natural processes contribute to these threats.
- evaluate potential solutions and preventive measures for mitigating each soil threat and understand the importance of adopting sustainable practices to counteract them.

Materials:

- Worksheet: Why is Soil Under Threat?
- Worksheet: Focus on Soil Threats
- Internet access

MM5: Dig Out the Secrets of Soil
L5: Current Soil Issues

ACTIVITY INSTRUCTIONS

Activity 1: Soil Threats Introduction (15 minutes)

1. Watch the video Land & Soil Policy Episode #3: Why is soil under threat? (6:17min) and have learners complete Worksheet: Why is Soil Under Threat?
2. Discuss as a class

Activity 2: Focus on Soil Threats (35 minutes)

1. Divide the learners into six groups.
2. Assign each group a ‘threat’: erosion, organic matter decline, compaction, salinisation, contamination, or biodiversity loss.
3. Have each group complete Worksheet 2: Focus on Soil Threats. The groups will need to manage their time and should assign the following roles: timekeeper, researcher(s), recorders, etc.
4. Have each group present their findings to the class.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L5: Current Soil Issues

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, skip Activity 1 or have learners watch the video at home.

Extension: For a longer class, give learners more time for research and have each group present their findings as a presentation.

Option B: Conduct the 'soil glue' experiment: https://www.nrcs.usda.gov/sites/default/files/2022-10/soil_glue_lesson_plan.pdf

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Land & Soil Policy Episode #3: Why is soil under threat? [6:17min]
https://www.youtube.com/watch?v=VB8_mE0Xrh4&ab_channel=TheInstitutionofEnvironmentalSciences%28IES%29

Soil Glue Experiment: https://www.nrcs.usda.gov/sites/default/files/2022-10/soil_glue_lesson_plan.pdf

EU Soil Observatory: https://esdac.jrc.ec.europa.eu/esdacviewer/euso-dashboard/

Human and Soil Interactions https://www.soils4teachers.org/human-soil-interactions

Soil Protection https://joint-research-centre.ec.europa.eu/scientific-activities-z/soil-protection_en

Soil threats (from recare-hub.eu project) https://recare-hub.eu/12-soil-threats

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Visit or invite local farmers, agricultural experts, and environmental scientists to discuss how they combat soil issues on their land.

L5: WHY IS SOIL UNDER THREAT?

Answer the following questions as you watch the video:

What was the important insight from the IES report?

Why is soil under threat?

What human actions put soil at risk?

What threats to soil do they list?

What is important about the rate of erosion vs. the rate of soil formation?

What is erosion?

What can happen when we build on top of soil?

What can happen when we use heavy machinery and / or keep livestock?

L5: WHY IS SOIL UNDER THREAT?

How can growing and agricultural practices affect soil?

How can soil become contaminated?

What is salinization?

What is acidification and nitrification?

L5: FOCUS ON SOIL THREATS

Group Name:

Soil Threat:

You are going to research a soil threat. The below link is a good starting resource, but you should use your research skills to find other sources of information.

https://joint-research-centre.ec.europa.eu/scientific-activities-z/soil-protection_en

What is your threat? Why is it a problem?

What makes your threat happen? What is the process of your threat?

How have humans made your threat worse?

Give an example of when your threat may happen (e.g. natural disaster, weather patterns, etc.)? Where might it happen?

L5: FOCUS ON SOIL THREATS

What bad things can happen when your threat happens?

How does your threat affect humans? Other animals or living beings? Plants?

How can we prevent your threat from happening?

Find 3 examples of people or companies around the world who are helping to prevent or mitigate your threat?

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Experimentation and Exploration

Lesson 6: Salinisation Experiment

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Salinisation Experiment

In this lesson, we will continue to explore threats to soil. Learners will focus on salinisation and learn about the causes and effects of salinisation through a hands-on experiment.

Vocabulary: Salinisation, Salinity Metre, Calibrate, Salinity Threshold

In this lesson, the learner will:

- Begin to understand salinisation
- Work as a team and follow experiment directions
- Record and analyse information

Materials:

- Worksheet: Salinisation Experiment
- Teachers' Guide
- Salinity / EC Metres
- Dry soil samples, preferably oven dried
- 100 ml beakers
- Weighing scales
- Mortars and pestles or rolling pins
- Distilled water
- Stirring rods
- Standard solution (1413 or 12880 EC)
- Internet access

MM5: Dig Out the Secrets of Soil
L6: Salinisation Experiment

ACTIVITY INSTRUCTIONS

Activity 1: Pre-experiment Questions (15 minutes)

1. Divide learners into groups and have them discuss the following questions. Share as a class:
   a. Why can't you drink ocean water if you are stranded on an island or lost at sea?
   b. Why should we be concerned about the amount of salt in our soil?
2. Briefly inform learners that they will be conducting an experiment to determine the salinity of different soil samples. Tell learners where their four soil samples come from (e.g. garden, construction site, etc.). Have learners complete the pre-experiment questions on Worksheet: Salinisation Experiment

NOTE: See Teacher's Notes. There is preparation needed for this experiment.

Activity 2: Experiment (25 minutes)

1. In their groups, have learners conduct the experiment using the worksheet: Salinisation Experiment. Monitor and help learners as needed.

Activity 3: Post-experiment Questions (10 minutes)

1. Discuss the post-experiment questions and results as a class.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L6: Salinisation Experiment

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, have learners do the pre and post experiment questions at home. Have each group only analyse two soil samples.

Extension: For a longer class, allow more time for class discussion of the results and answers to the questions. If you want to spread this lesson out to two lessons, learners can collect and dry the soil samples.

Option B: Conduct the 'soil glue' experiment: https://www.nrcs.usda.gov/sites/default/files/2022-10/soil_glue_lesson_plan.pdf

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Soil Salinisation Experiment: https://www.nccma.vic.gov.au/sites/default/files/publications/nccma-7468_-_salinity_activities_booklet.pdf

Soil Glue Experiment: https://www.nrcs.usda.gov/sites/default/files/2022-10/soil_glue_lesson_plan.pdf

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Visit or invite local farmers, agricultural experts, and environmental scientists to discuss how soil salinisation affects their practice.

L6: SALINISATION EXPERIMENT

You are going to conduct an experiment to look at soil salinisation.

First, answer the following pre-experiment questions before conducting the experiment:

Where do your soil samples come from and how do you think this will affect the salinity level of the samples?

Which site do you think will have the highest salinity? The lowest? Why?

What plants do you think can grow in high salinity? What about low salinity?

What are the potential environmental factors that could influence the salinity levels in the soil, and how can we account for them during the experiment?

How can we ensure the collected soil samples are truly representative of the site area and free from contaminants that could affect the salinity measurements?

How might variations in the size or grinding of the soil particles affect the accuracy and consistency of the salinity measurements?

L6: SALINISATION EXPERIMENT

Now you will conduct the experiment by following the instructions below.
Be sure to read the instructions fully before starting the experiment.
This experiment is found in:
https://www.nccma.vic.gov.au/sites/default/files/publications/nccma-7468_-_salinity_activities_booklet.pdf

Equipment needed

EC/Salinity meter
Four dry soil samples (oven dried)
Four 100 ml beaker
Weighing scales
Mortar and pestle or rolling pin
200 ml distilled water
Stirring rod
Standard solution (1413 or 12880 EC)

1. Your teacher will give you soil samples from four different sites. Record the location and use of the sites below:
    a. Site 1:
        i. Location:
        ii. Use (e.g. gardening, construction site, etc.):
    b. Site 2:
        i. Location:
        ii. Use (e.g. gardening, construction site, etc.):
    c. Site 3:
        i. Location:
        ii. Use (e.g. gardening, construction site, etc.):
    d. Site 4:
        i. Location:
        ii. Use (e.g. gardening, construction site, etc.):
2. Take the soil sample from site 1 and weigh out 10 grams of dry soil.
3. Grind the soil with a mortar and pestle or rolling pin until it is smooth and there are no lumps. Remove any gravel, sticks, leaves, etc.
4. Put the 10 grams of soil into a 100ml beaker and add 50ml of distilled water.
5. Stir and let it sit for 5 minutes.
6. Calibrate the meter using a standard solution (1413 or 12880 EC). Ask your teacher for help.
7. Rinse the meter probe with distilled water.
8. Stir the soil and water solution again.

L6: SALINISATION EXPERIMENT

9. Put the meter probe into the soil and water solution, and record the reading in the table below. Be sure to note the measurement unit!
10. Wash all of your equipment and repeat for sites 2-4.

Sample	Location	Land Use	Salinity (EC µS/cm)
Site 1			
Site 2			
Site 3			
Site 4			

L6: SALINISATION EXPERIMENT

Post-experiment questions

Once you have all of your readings, compare your reading to the ones below to identify what could be grown in the soil (Waterwatch North Central CMA, 2007).

Tolerance Rating	Crop	Salinity Threshold (EC µS/cm)
Very high	Barley	5,300
High	Cotton	5,100
Medium	Sugarbeet	4,700
Low	Wheat Soybean Oats Peanut Rice Maize Potato Onion	4,000 3,300 3,300 2,100 2,000 1,100 1,100 800

What could be grown in site 1?

_____

_____

_____

What could be grown in site 2?

_____

_____

_____

What could be grown in site 3?

_____

_____

_____

L6: SALINISATION EXPERIMENT

What could be grown in site 4?

Which site had the highest salinity? The lowest? Why do you think this was the case?

Did your prediction of which site had the highest and lowest salinity match your results? Why or why not?

Do you think your community needs to worry about soil salinisation? Why or why not?

What could your community do the help reduce the threat of soil salinisation?

Share your results with the class. Were your results consistent with the other groups? Why or why not?

L6: TEACHERS' GUIDE

Preparation

Before class, collect soil samples from four sites and record where you collected them from. Be sure to note what the land is used for (e.g. gardening, tilled field, construction site, etc.) and the exact location. You should have enough soil from each site that each group can analyse all four sites.

When collecting the samples, take three to four samples from each of your four sites. Mix your samples from site 1 thoroughly together to provide a representative sample. Repeat with sites 2-4.

Dry the soil from each site separately in an oven for approximately one hour at 150 °C. For example, dry the soil from site 1 first, then from site 2, etc.

Avoid contaminating the soil samples or mixing soil from the different sites. Be sure to properly label each sample.

NOTE: You can spread this lesson over two lessons and have learners collect samples from one site per group and dry the soil themselves if time permits.

During the Experiment

Distribute the equipment needed to each group. Monitor and help the groups as needed, especially with the Salinity/EC Metres.

SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 7: Soil Texture Experiment Preparation

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil Texture Experiment Preparation

In this lesson, learners will explore how to classify soil based on their physical properties. Learners will learn about soil texture and structure. Then, learners will prepare for a hands-on experiment which will be conducted in the next lesson. This preparation involves collecting soil samples, making observations about their samples and preparing the soil for their experiments.

Vocabulary: Abiotic, Ecosystems, Fertility, Sedimentation, Silt, Nutrient

In this lesson, the learner will:

- Understand the components of soil
- Connect soil components with different properties and functions of soil
- Begin to understand soil texture
- Engage in critical thinking about the soil in their community

Materials:

- Worksheet: Know Your Soil's Texture
- Worksheet: Soil Texture Experiment Preparation
- Teachers' Guide
- Soil samples (from school yard, garden, etc.)
- Two jars or tall containers (5-10cm diameter 20-40cm tall) for each group
- Two smaller containers for each group
- Shovel for each group
- Tape for labelling
- Marker for labelling
- Ruler or measuring tape for each group
- Distilled water

MM5: Dig Out the Secrets of Soil
L7: Soil Texture Experiment Preparation

ACTIVITY INSTRUCTIONS

Activity 1: Know Your Soil's Structure (15 minutes)

1. Divide learners into groups of 2 or 3.
2. Show the video: Soil Basics: Texture [4m:17s] as a preparation for the experiment in activity 2. Have learners complete the worksheet: Know Your Soil's Texture.
3. Show the soil texture triangle (in the media box) as a reference and facilitate a class discussion with the following questions.
   a. How many main divisions does a textural triangle have?
   b. Would you expect to commonly find pure soils (pure loam, pure clay,...) or mixed soils?
   c. What type of soil is it if you can make a small flat ribbon?
   d. What types of soil do you expect to find around the school? why?

Activity 2: Experiment Preparation (35 minutes)

1. Divide learners into groups of 2 or 3
2. Distribute the worksheet: Soil Texture Experiment Preparation, two jars and lids, and one shovel to each group.
3. Go through the instructions with the learners about how to collect a soil sample.
4. Allow learners to go outside and collect two soil samples per group, limit the collection and recording time to 15 minutes. They should follow the instructions and answer questions from the worksheet: Soil Texture Experiment Preparation Part 1.
5. Once learners are back in the classroom, have learners follow the instructions in the worksheet: Soil Texture Experiment Preparation Part 2. See Teacher's Notes.
6. Have learners take their jars and follow the instructions on the worksheet: Soil Texture Experiment Preparation Part 3.
7. Facilitate a brief classroom discussion about the questions they answered on the worksheet.
8. You may consider collecting the groups' worksheets as these will be needed for the next lesson.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L7: Soil Texture Experiment Preparation

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, have learners complete Activity 1 as a flipped classroom and facilitate only a brief discussion of the answers. Only have learners collect one soil sample.

Extension: For a longer class, after Activity 2, have learners watch the videos Simple Soil Testing / How To Test Your Soil (see media box) and The video Video: Soil Basics: Structure (see media box).

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Soil Basics: Texture https://www.youtube.com/watch?v=8nU26sXVNS4 [4:17min]

Soil Basics: Structure https://www.youtube.com/watch?v=nkw07WdRXoc [4:38min]

Simple Soil Testing // How To Test Your Soil https://www.youtube.com/watch?v=UoD-cUMkRZY [6:51min]

Soil Texture Triangle https://hgic.clemson.edu/factsheet/soil-texture-analysis-the-jar-test/

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Have learners collect a wider sample of soil from the local area and repeat the experiment. They should choose soil from areas they believe have bad soil, and areas where they believe have good soil. What do they find?

Have learners interview a farmer about the type of soil they find on their land. How does this affect their farming practices and crops that are grown?

L7: KNOW YOUR SOIL'S TEXTURE

While watching the video, answer the following questions:

What is soil texture?

What are the main components of soil?

How many types of soil texture are discussed in the video? Can you name them all?

Which side of the triangle is gritty?

What type of soil texture should you expect in the middle of the triangle?

What types of soil structure do you think you can find in your community?

L7: SOIL TEXTURE EXPERIMENT PREPARATION

Part 1: Collection and Recording Information

Create a group name:

You will conduct an experiment to find out what type of soil texture is in your community. First, you will need to collect two soil samples to test!

Equipment Needed

Two jars
Shovel

1. Pick two areas to collect soil from. You may choose a local park, your school or other publicly accessible area.
2. Gather an amount equivalent to a coffee cup of soil from each of your chosen area. Put them into separate jars and label the jars sample 1 and sample 2.
3. When you gather your sample, be sure to record the following information:

Exact location of the soil (you may drop a pin on google maps to show the exact location of your soil sample):

Sample 1:

_____

_____

Sample 2:

_____

_____

Time and date of collection:

Sample 1:_____

Sample 2:_____

Describe what you see in this location (plants, animals, landscape, man-made materials and structures):

Sample 1:

_____

_____

L7: SOIL TEXTURE EXPERIMENT PREPARATION

Sample 2:

_____

_____

What is this location used for (e.g., gardening, grass, beach, to plant flowers, etc.):

Sample 1:

_____

_____

Sample 2:

_____

_____

Why did you pick this location?

Sample 1:

_____

_____

Sample 2:

_____

_____

Colour of your soil (colour relates to how much organic material that has decayed is in the soil, this is called humus. The darker the soil, the more organic material, such as leaves, twigs, and animals, is in the soil.):

Sample 1:

_____

_____

Sample 2:

_____

_____

Texture (does your soil feel grainy, like clay, like sand?):

Sample 1:

_____

_____

L7: SOIL TEXTURE EXPERIMENT PREPARATION

Sample 2:

_____

_____

Put your soil sample into a jar and bring the soil sample with you to the classroom - you will be analysing the texture and components of the soil in class.

Part 2: Separating the Soil Samples

You are going to conduct two experiments next class and need different amounts of soil for each experiment.

Equipment Needed

Your two soil samples in your jars
Two smaller containers
Tape
Marker

1. Take your first soil sample and take a handful of soil out of the jar.
2. Place this handful of soil into one of your smaller containers.
3. Label the jar of your first soil sample as your group name, sample 1.
4. Label the smaller container of your first soil sample as your group name, sample 1.
5. Take your second soil sample and take a handful of soil out of the jar.
6. Place this handful of soil into your second smaller container.
7. Label the jar of your second soil sample as your group name, sample 2.
8. Label the smaller container of your second soil sample as your group name, sample 2.
9. Give your properly labelled smaller containers to your teacher for safe keeping. You will use these in the next lesson.

Part 3: Jar Experiment Preparation

Now, take both of your properly labelled jars and follow the instructions below:

Equipment Needed

Your two soil samples in the jars
Distilled water
Ruler

L7: SOIL TEXTURE EXPERIMENT PREPARATION

1. Take your jars with your soil sample and make sure that your jar is one-third full of soil. You should have 5-8cm of empty jar above your soil.

2. Shake your jar gently to level the soil, then measure the soils depth (A):
- Sample 1: _____cm
- Sample 2: _____cm

3. Fill the jars with distilled water.

4. Close and seal the jars tightly.

5. Give the jars a good shake. Let your jars sit until your layers have settled. The heavier materials will sink to the bottom and the lighter materials will rise to the top.

6. We will be looking at three layers:

a) the course sand and grit layer
b) silt layer
c) clay layer

7. Before you leave the classroom, record the following:

a) For each sample, what is your initial guess regarding your soil sample structure? How much sand does it have? How much silt does it have? How much clay does it have?

Sample 1:

_____
_____
_____
_____

Sample 2:

_____
_____
_____
_____

You will complete the rest of the experiment in your next lesson.

L7: TEACHERS' GUIDE

Teacher preparation before the lesson:

Be sure to have enough jars and smaller containers for each group to have two jars and two smaller containers. Each group will also need one shovel and / or gloves to collect their soil samples.

Have learners collect soil samples, or in the case of weather conditions or time, have enough soil samples already collected for each group to observe and use two soil samples. If you collect the soil samples they are using, you will need to give them the exact location. They can then use google maps terrain to look at where you got the sample from to fill out the questions on their experiment preparation worksheet.

During in-class soil collection:

Give learners boundaries for collecting their samples (e.g. they cannot leave school grounds, certain areas are off-limits - e.g. flower beds around the school, they can go to the beach or park nearby if within walking distance.

NOTE: Be sure to seek approval to collect soil samples from any location you send the learners to before the lesson so learners know exactly where it is OK and not OK to take soil samples from. Set a time limit for them to collect samples and record the information needed about their samples.

In-class after soil sample collection:

Once learners come back to the classroom, have learners take a small handful of the soil from their jar and store this in a separate container; their jar should be at least one-third of soil after they take their smaller sample from their container. They will have two different experiments in the next lesson.

Ensure that both the jars and smaller containers are properly labelled (e.g. Group 1 Name Sample 2) so that groups can identify their samples in the next lesson.
Collect and place the smaller containers in a safe place so they can be used for the next lesson.

After each group has added water and shaken their jars, collect and place the jars in a safe place so they can be used for the next lesson. The jars should be kept in a place where they will be undisturbed between lessons.

NOTE: If you only have one lesson to dedicate to this experiment, prepare the soil samples for the learners in advance of the lesson, letting them sediment for 1 day and have the learners only complete the following lesson.

SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 8: Soil Texture Experiment

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil Texture Experiment

A follow-on from the previous lesson, learners will explore how to classify soil based on their physical properties. Using a hands-on experiment, learners will be introduced to field work and laboratory work while gaining a deeper understanding of the soil around them.

Vocabulary: Abiotic, Ecosystems, Fertility, Sedimentation, Silt, Nutrient

In this lesson, the learner will:

- understand the components of soil
- connect soil components with different properties and functions of soil
- begin to understand soil texture
- engage in mathematics through an experiment
- engage in critical thinking about the soil in their community

Materials:

- Worksheet: Soil Texture Experiment
- Teachers' Guide
- Soil samples from the last lesson
- Ruler or measuring tape for each group

MM5: Dig Out the Secrets of Soil
L8: Soil Texture Experiment

ACTIVITY INSTRUCTIONS

Activity 1: Experiment Instructions (10 minutes)

1. Ask learners to return to their groups from the previous lesson.
2. Watch the video Simple Soil Testing // How To Test Your Soil [6:51min]
3. While watching the video, have learners take notes on the instructions for the experiment.
4. Distribute Worksheet: Soil Texture Experiment and briefly discuss the instructions for both experiments. You will need to monitor groups during the experiments to ensure that instructions are being followed.

Activity 2: Experiment (40 minutes)

1. Give each group their settled jars and smaller containers of both soil samples.
2. Have learners follow the instructions for each experiment and recording of information from the worksheet: soil texture experiment.
3. Have each group share their results and answers to their questions. Facilitate a whole class discussion based on the questions on their worksheet and:
    a. Does the class agree on the types and textures of the soils found in their community?

NOTE: Do not dispose of their jars and soil samples as they will be used in Lesson 9: Soil Test Experiment to test the nitrogen, phosphorus and potassium levels of the soil. Be sure that learners keep their worksheets from Lessons 7 and 8 (you may collect them for safe keeping) as they will need to share the soil sample location and description for Lesson 9. The jars will need to be re-shaken and left to settle 24 hours before you conduct Lesson 9.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

• Three things they feel they have learnt from the tasks.
• Two things they found most interesting and would like to explore more.
• One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L8: Soil Texture Experiment

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, have learners complete Activity 1 as a flipped classroom and facilitate only a brief discussion of the instructions. Have learners complete the post-experiment questions at home and discuss them in the next lesson.

Extension: For a longer class, after Activity 2, as a class, have learners create a map of where each soil sample was taken. Learners may now place their results from the experiment on the map. Have learners share why they think these soil textures and colours were found in each area.

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Simple Soil Testing // How To Test Your Soil https://www.youtube.com/watch?v=UoD-cUMkRZY [6:51min]

Soil Basics: Texture https://www.youtube.com/watch?v=8nU26sXVNS4 [4:17min]

Soil Basics: Structure https://www.youtube.com/watch?v=nkw07WdRXoc [4:38min]

Soil Texture Triangle https://hgic.clemson.edu/factsheet/soil-texture-analysis-the-jar-test/

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Have learners collect a wider sample of soil from the local area and repeat the experiment. They should choose soil from areas they believe have bad soil, and areas where they believe have good soil. What do they find?

Have learners interview a farmer about the type of soil they find on their land. How does this affect their farming practices and crops that are grown?

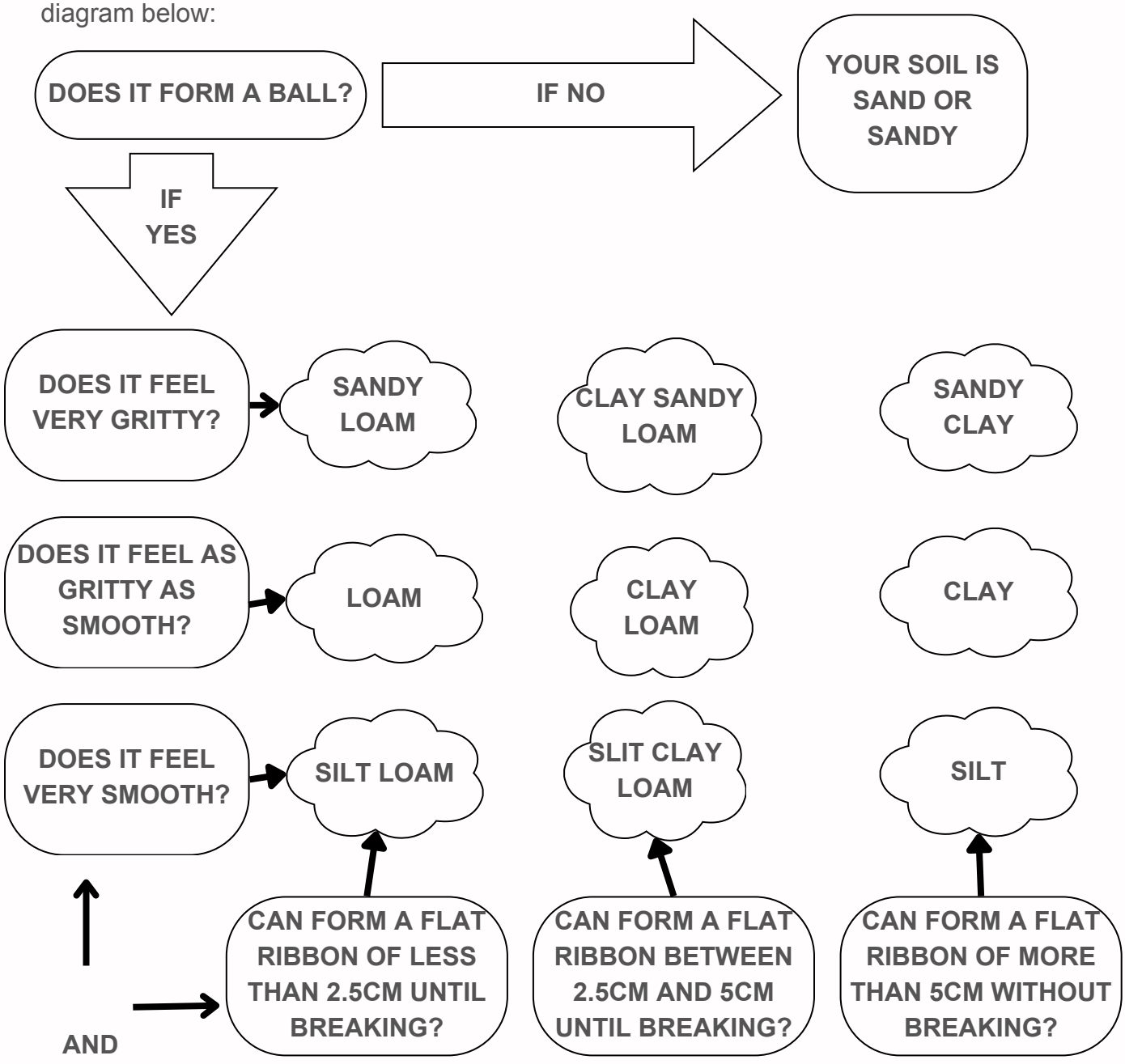
L8: SOIL TEXTURE EXPERIMENT

You will conduct two experiments to find out what type of soil texture is in your community. Briefly look at your worksheet from the last lesson to remind yourself of the details about both of your soil samples. You will need to refer to information on this worksheet to conduct your experiments.

Your teacher will first give you your group's soil samples which you kept in the smaller containers.

You are now going to do a quick test on your soil to determine its texture. The diagram depicts different behaviours of the soil samples after working it with your hands.

Take your first soil sample, add a small bit of water just to moisten the soil and follow the diagram below:



L8: SOIL TEXTURE EXPERIMENT

What type of texture is your soil sample 1?_____

Repeat the steps with your second soil sample.

What type of texture is your soil sample 2?_____

You are now going to conduct another scientific experiment to determine the mineral component of your soil.

The mineral component of soil is made up of different size particles called sand, silt, and clay. In this test, you will mix soil and water in a jar and then let the soil sink to the bottom so that these different-sized particles form different layers. By measuring the layers, you will be able to calculate the percentage of sand, silt, and clay in your soil.

Your teacher will give you your group's jars with your soil samples in them.
As these have settled overnight, do not shake the jars!

Follow the steps below for each jar:

Observe your jar and see that it has separated into three layers.

The largest and heaviest particles, called sand, will be at the bottom of your jar. Measure the depth of the sand in the jar (B)

Soil sample 1:_____
Soil sample 2:_____

The medium-sized particles, called silt, can take hours to settle. This is why we left our jars overnight in the classroom. Measure the depth of the silt layer (C):

Soil sample 1:_____
Soil sample 2:_____

The smallest particles, called clay, can take even longer to settle. Since we do not have time to allow the jars to sit for more time, we can assume that the depth of the clay layer (D) will be equal to the total depth of the soil (A; this was recorded in the last lesson) minus the depth of the sand layer (B) and the silt layer (C);

L8: SOIL TEXTURE EXPERIMENT

Here is a mathematical formula for you:

A - (B + C) = D

Remember to add B and C together first.

For example:
6cm - (2cm +1.5cm) = D
6cm - 3.5cm = D
2.5cm = D

Therefore, for this example, the clay layer (D) is 2.5cm.

Now, find the depth of clay layer for each of your samples:

Soil sample 1: _____ of clay layer
Soil sample 2:_____ of clay layer

Now that you have measured each of the layers, record your information below:

Soil Sample 1:

Sample location and date:_____
Total soil depth in cm (A):_____
Sand layer depth in cm (B):_____
Silt layer depth in cm (C):_____
Clay layer depth in cm (D):_____

Soil Sample 2:

Sample location and date:_____
Total soil depth in cm (A):_____
Sand layer depth in cm (B):_____
Silt layer depth in cm (C):_____
Clay layer depth in cm (D):_____

Now you need to find the percentage of each layer. To do this you need to use the following equation:

(Sand layer depth in cm (B) / Total soil depth in cm (A)) X 100 = percentage of sand layer)

L8: SOIL TEXTURE EXPERIMENT

For example, the total soil depth in cm might be 6 cm (A), and the sand layer depth in cm might be 2 cm (B), so the equation would be:

(B/A) X 100 = %
(2cm/6cm) X 100 = %
(0.3333) X 100 = %
33.33% = % of sand layer

Your turn: find the percentage of each of your layers:

Soil Sample 1:

1. % of sand layer: _____
2. % of silt layer: _____
3. % of clay layer: _____

Soil Sample 2:

1. % of sand layer: _____
2. % of silt layer: _____
3. % of clay layer: _____

Using the percentages, you are now going to look at the triangle below to try to guess the type of soil texture for each of your samples.

To use the triangle, start from the bottom left corner and move horizontally to the right until you reach your sand percentage. Then move up along that line until you reach your clay percentage. Finally, move diagonally to the left until you reach your silt percentage.
The name of your soil type will be in the area where all three lines meet.

L8: SOIL TEXTURE EXPERIMENT

https://hgic.clemson.edu/factsheet/soil-texture-analysis-the-jar-test/

Looking carefully at the results on the triangle you got for your soil samples, write what type of soil each of your samples are (e.g. sandy loam, clay, etc.):

1. Soil sample 1: _____
2. Soil sample 2: _____

L8: SOIL TEXTURE EXPERIMENT

Now answer the following questions:

For each soil sample, do the results match the ones you obtained in the first experiment?

Why do you think it did or didn't?

Were you surprised by the results? Why or why not?

Why do you think the location of each soil sample has this type of soil texture?

What do you think the benefits of this soil texture are (you may use google to help here!)?

What do you think the problems of this soil texture are (you may use google to help here!)?

What solutions to the problems of this soil texture can you think of (e.g adding compost)?

L8: TEACHERS' GUIDE

When you hand back the jars and smaller containers, ensure that learners are not shaking the jars as this will mix up their layers and result in an invalid experiment.

You will need to monitor the experiments during the class to ensure that learners are following the instructions and recording all necessary information.

If learners are confused as to how to use the triangle, it may help to show them this website: https://hgic.clemson.edu/factsheet/soil-texture-analysis-the-jar-test/

If the soil falls within the "loam" classification, their soil is in a sweet spot. Loam soil is usually good for root penetration into the soil and is the most fertile and adequate for farming, as long as your soil drains well the answer is that they probably do not need to take any action.

But if for instance, they have 'sandy' soil, this is not nutrient rich as it washes off. A possible solution is to add organic matter such as compost or hummus so that it increases organic contain and therefore retains water better.

If you have clay soil, it is also not ideal and also compost will break it up naturally.

NOTE: If you only have time for one lesson, prepare the soil for the learners in advance of this lesson and only have learners complete this lesson.

SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 9: Soil Nutrient Test

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil Nutrient Test

In this lesson, students will explore nitrogen, phosphorus and potassium in soil. Learners will conduct a hands-on experiment to test soil in their area. Note: This lesson requires the purchase of a soil test kit (see Teacher's Notes).

Vocabulary: Nitrogen, Phosphorus, Potassium, Nutrient, Surplus, Deficiency

In this lesson, the learner will:

- discover the amount of nitrogen, phosphorus and potassium in soil
- follow directions
- record and analyse information

Materials:

- Worksheet: Soil Test
- Teachers' Guide
- Soil Test Kit
- Jars and soil samples from Lesson 8

MM5: Dig Out the Secrets of Soil
L8: Soil Texture Experiment

ACTIVITY INSTRUCTIONS

NOTE: See Teacher's Notes for test kit suggestions. The soil test kits include a reagent for pH. Keep this for Lesson 10.

You should keep the soil samples from various places which the learners used in Lesson 8. Be sure that learners kept their worksheets from Lessons 7 and 8. The jars will need to be re-shaken and left to settle 24 hours before you conduct Lesson 9. If you do not conduct the previous experiment, please follow directions in Lesson 7 for collecting soil samples.

Activity 1: Soil Test Kit Preparation (10min)

1. Divide learners into the groups they worked in during Lessons 7 and 8.
2. Have learners collect their soil samples from Lesson 8.
3. Go through the instructions with the learners about how to use the soil test kit.

NOTE: The soil test kits come with instructions which will need to be communicated to learners. We have provided a video: Garden Soil Testing w/ Rapid Test Kit - Instructions and Demo (PH, Nitrogen, Phosphorous, Potassium) [13:50min] which shows how to use a soil test kit. However, each brand of soil test kits may be different so it is important to read the instructions for the test kit that you purchased.

Activity 2: Soil Test (40min)

1. Have learners complete the pre-experiment questions on Worksheet: Soil Test. Discuss as a class.
2. Using the soil test kit, have learners prepare their soil sample to test for nitrogen, phosphorus and potassium.
3. After each group has tested their soil sample, have them record their results and complete the post-experiment questions on Worksheet: Soil Test. Discuss as a class.
4. Have learners write their results on the board in a table. Allow learners to discuss the following question before discussing as a class:
    a. Comparing your results with the rest of the classes', were there any variations in nitrogen, phosphorus, or potassium levels among different sampling locations within the same area? What factors could explain these variations and how might they be addressed in future soil testing and management efforts?

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L8: Soil Texture Experiment

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, have learners complete the pre-experiment and post-experiment questions at home.

Extension: For a longer class, have learners watch the video Garden Soil Testing w/ Rapid Test Kit [13:50min] (see Media Box).

Option B: Have learners refer to their notes from Lesson 3. Create a poster on the importance of nitrogen, phosphorus and potassium in soil, their soil test results and recommendations for improving the nutrients in their soil sample. See Media Communication: Poster.

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Garden Soil Testing w/ Rapid Test Kit - Instructions and Demo (PH, Nitrogen, Phosphorous, Potassium) [13:50min]
https://www.youtube.com/watch?v=K9LgbrkdVnY&ab_channel=GreatLakesPrepping

Understanding Our Soil: The Nitrogen Cycle, Fixers, and Fertilizer [4:29 min]
https://www.youtube.com/watch?v=A8qTRBc8Bws&ab_channel=JimiSol

Free Organic Nitrogen Sources For Plants And Garden! Our Top 10! [10:54 min]
https://www.youtube.com/watch?v=xJqkXK3htyY&ab_channel=CountryLivingExperience%3AAHomesteadingJourney

Is there enough phosphorus in your soil? | DIY garden projects | Gardening Australia [5:02 min]
https://www.youtube.com/watch?v=_DPPNQsUvgs&ab_channel=GardeningAustralia

Potassium in Plant Health [1:44 min] https://www.youtube.com/watch?v=86Xb8Wf3qX4&ab_channel=CropNutritionfromTheMosaicCompany

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Use some of their recommendations for improving the nutrients in their soil sample in a polytunnel or school garden. Try different suggestions and label each area as to what treatment was given. Compare the results of each treatment.

Speak to local farmers and growers about what nutrients are deficient in your area.
Contact your local county council about fertiliser regulations, recommendations and schemes.

L9: SOIL TEST

Group name:

You are going to test your soil for nitrogen, phosphorus and potassium.

First, you will collect your soil samples from the previous experiment. Your teacher will tell you if you are to test both soil samples or only one.

Your teacher will go through the instructions for how to conduct the soil test.

First, you will need to answer the following pre-experiment questions:

What type of soil were each of your samples?

Sample 1:_____
Sample 2:_____

Look up these types of soil and make a guess as to if your soil samples will have too much, just enough, or deficient levels of nitrogen, phosphorus and potassium.

Sample 1:

N:_____
P:_____
K:_____

Sample 2:

N:_____
P:_____
K:_____

Why is it important to have a sufficient level of nitrogen, phosphorus and potassium?

_____
_____
_____

What happens if you have too little nitrogen, phosphorus and potassium?

_____
_____
_____

L9: SOIL TEST

What happens if you have too much nitrogen, phosphorus and potassium?

_____

_____

_____

Now, you are going to test your soil sample(s) for nitrogen, phosphorus and potassium. Each kit has slightly different instructions, so be sure to listen to your teacher.

First, start with the nitrogen test. After you have completed this test, record the following information:

Sample 1 level of nitrogen:_____
Sample 2 level of nitrogen:_____

Then, move on to the phosphorus test. Record the following information:

Sample 1 level of phosphorus:_____
Sample 2 level of phosphorus:_____

Finally, finish with the potassium test. Record the following information:

Sample 1 level of potassium:_____
Sample 2 level of potassium:_____

Looking at your results and information you have learned about nitrogen, phosphorus and potassium, answer the following questions.

What nutrients are your soil samples deficient in? Which nutrients do they have too much of?

_____

_____

_____

Are there any nutrients which are sufficient? Why do you think this is?

_____

_____

_____

L9: SOIL TEST

Did your predictions in your pre-experiment questions match your results? Why do you think this did / didn't match (think: is your soil sample from an area where fertiliser has been used or the soil has somehow been disturbed or drained of nutrients?)?

Find three plants which would be well suited for your soil conditions (some soil test kits contain a list of these plants).

Suggest three feeding / natural fertilising strategies to improve the nutrients in your soil based on your soil conditions. Why did you choose these strategies?

L9: TEACHERS' GUIDE

There are two soil test kits suggested:

Up to 60 soil samples using test tubes and reagent: https://www.quickcrop.ie/product/super-soil-test-kit-60-tests

Up to 8 soil samples using an integrated control / test tube chamber (additional test tubes will be needed if you choose this test kit as each test will need to sit for 10 minutes): https://www.thegardenshop.ie/soil-test-kit/

The soil test kits include a reagent for pH. Keep this for Lesson 10.

The soil test kits come with instructions which will need to be communicated to learners. We have provided a video: Garden Soil Testing w/ Rapid Test Kit - Instructions and Demo (PH, Nitrogen, Phosphorous, Potassium) [13:50min] which shows how to use a soil test kit. However, each brand of soil test kits may be different so it is important to read the instructions for the test kit that you purchased.

You should keep the soil samples from various places which the learners used in Lesson 8. Be sure that learners kept their worksheets from Lessons 7 and 8. The jars will need to be re-shaken and left to settle 24 hours before you conduct Lesson 9. If you do not conduct the previous experiment, please follow directions in Lesson 7 for collecting soil samples.

SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 10: Soil pH Experiment

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil pH Experiment

In this lesson, learners explore the significance of soil pH in plant growth through active listening and hands-on activities. They will delve into pH as a measure of acidity or alkalinity, emphasising its crucial role in soils and hence agriculture. By understanding plants' ideal pH ranges, acid rain's effects, and nutrient solubility, various practical aspects unfold. The experiment to measure soil pH fosters analytical skills and teamwork. The lesson equips learners with theoretical knowledge and practical know-how, enabling them to comprehend and apply the importance of pH for plant growth.

Vocabulary: Acidity, Alkalinity, Leaching, Water Solution, pH

In this lesson, the learner will:

- understand the concept of pH as a measure of acidity and alkalinity, and explain its relevance in soil for plant growth.
- increase the knowledge of the impact of pH on nutrient availability, microbial activity, and overall plant health in different soil types.
- apply practical skills by conducting a soil pH experiment

Materials:

- Worksheet: Soil pH
- Teachers' Guide
- pH reagent from soil test kit used in Lesson 9
- pH strips (and colour code)
- pH meter
- Droppers
- Containers for mixing soil and water
- Distilled water
- Internet access

MM5: Dig Out the Secrets of Soil
L10: Soil pH Experiment

ACTIVITY INSTRUCTIONS

Activity 1: Active Listening (10 minutes)

1. Watch the video Why is soil pH important to farmers? [5:25min].
2. Have learners answer the True / False questions on Worksheet: Soil pH Part 1.
3. Discuss as a class.

Note: Activity 2 requires teacher preparation. Please see Teacher's Notes.

Activity 2: Experiment (40 minutes)

1. Divide learners into small groups.
2. Give each group two soil samples and discuss their location.
3. Have learners complete the pre-experiment questions on Worksheet: Soil pH
4. Give each group a container, distilled water, a dropper, reagent from the soil test kit, a pH strip, and a pH metre (you may choose not to use a pH metre if you do not already have one; pH metres may be shared between groups). See Teacher's Notes.
5. Have learners follow the instructions on the worksheet: soil pH to complete the experiment.
6. Have learners record the results and answer the post-experiment questions on Worksheet: Soil pH.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L10: Soil pH Experiment

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, have learners complete Activity 1 at home.

Extension: For a longer class, have learners collect two soil samples per group to analyse instead of giving them soil samples.

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Why is soil pH important to farmers? [5:25min] https://www.youtube.com/watch?v=zQowljL8e5E

How to Use pH Litmus Strips to Measure pH in Vegetable Garden Soil - The Rusted Garden 2013 [3:07min] https://www.youtube.com/watch?time_continue=106&v=xIz2YPBXuZU&embeds_referring_euri=https%3A%2F%2Fwww.google.com%2F&source_ve_path=MzY4NDIsMzY4NDIsMjg2NjY&feature=emb_logo&ab_channel=GaryPilarchik%28TheRustedGarden%29

Garden Soil Testing w/ Rapid Test Kit - Instructions and Demo (PH, Nitrogen, Phosphorous, Potassium) [13:50min] https://www.youtube.com/watch?v=K9LgbrkdVnY&ab_channel=GreatLakesPrepping

CALIBRATE A PH METER (step by step) + How To Use PH meter [9:25min] https://www.youtube.com/watch?v=2ZmSBKKINEc

Soil pH Lab https://edibleschoolyard.org/resource/soil-ph-lab

Why does the pH affect plant growth? [1:32min] https://www.youtube.com/watch?v=PPv1qwfCJ24

Soil Acidity and Adjusting Soil pH https://geo.libretexts.org/Bookshelves/Soil_Science/Soils_Laboratory_Manual_(Moorberg_and_Crouse)/05%3A_Soil_Chemistry/05.2%3A_Soil_Acidity_and_Adjusting_Soil_pH

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Ask a farmer or grower if they test for soil pH and if so, what type of soil is found in their growing areas. How do they adjust soil pH if needed?

L10: SOIL PH

As you watch the video, answer the following true / false questions.
Include an explanation as to why you think it is true or false.

1. pH measures the concentration of H+ ions in a water solution. T / F

   _____

2. A pH of 7.0 is considered acidic. T / F

   _____

3. Soils used for agriculture typically have a close to neutral pH. T / F

   _____

4. Acid rain can damage ecosystems, harm aquatic life, erode buildings and monuments, and negatively impact soil quality. T / F

   _____

5. Soil pH does not impact microbial decomposition and nutrient access. T / F

   _____

6. Leaching and certain fertilisers cannot alter soil pH. T / F

   _____

7. Monitoring soil pH is essential for cultivating healthy crops. T / F

   _____

L10: SOIL PH

You are going to test soil pH using three different tests.

Before you conduct the experiment, answer the following pre-experiment questions.

What do you think the soil pH is of both samples? Why do you think this?

Sample 1:

_____

_____

Sample 2:

_____

_____

Why is soil pH important?

_____

_____

_____

How does pH affect nutrient availability and absorption?

_____

_____

_____

What are the optimal pH ranges for common plants?

_____

_____

_____

Now you will conduct the experiment. First, record the location that each soil sample was collected from. Note the features of the location (e.g. was it a garden, construction site, did it have any plants growing there, etc.?):

Sample one:

_____

_____

_____

Sample two:

_____

_____

_____

L10: SOIL PH

First pH test: pH test strips

Equipment needed

Soil samples
Containers
Distilled water
pH strip and colour code

1. Take ⅓ of your first soil sample and place it in a separate container.
2. Mix with distilled water until it is the consistency of a milkshake.
3. Take your pH strip and put it in the solution for 20-30 seconds.
4. Remove it from the solution and gently rinse with distilled water to get rid of any clumps of dirt.
5. Compare the colour to the colour scale found with the pH strip packet.
6. Record the pH below.
7. Repeat with soil sample two.

Soil sample 1 pH:_____

Soil sample 2 pH:_____

Second pH test: pH reagent from soil test kit

Equipment needed

Soil samples
pH reagent and instructions from soil test kit
Dropper

1. Take ⅓ of your first soil sample and place in a separate container.
2. Follow the instructions that came with the soil test kit.
3. Record the pH below.
4. Repeat with soil sample two.

Soil sample 1 pH:_____

Soil sample 2 pH:_____

L10: SOIL PH

Third pH test: pH metre

Equipment needed

Soil samples
pH metre
Containers
Distilled water

1. Take ⅓ of your first soil sample and place in a separate container.
2. Add distilled water to your soil sample and mix well.
3. Place the pH metre into the solution, ensuring that you do not go past the immersion line.
4. Turn on the pH metre to get a reading.
5. Record the reading below.
6. Turn off the pH metre and rinse with distilled water.
7. Repeat with soil sample two.

Soil sample 1 pH:_____

Soil sample 2 pH:_____

Now, compare your results for each soil sample and answer the following questions:

Did your guess in the pre-experiment questions match your results? Why do you think it did or didn't?

_____
_____
_____

Did the pH strip, pH reagent and pH metre give you the same results? Why do you think they did or didn't?

_____
_____
_____

Is your pH suitable for growing plants? Why or why not?

_____
_____
_____

L10: SOIL PH

If your pH is very high or very low, why do you think this is?

Find two ways you can fix your pH if it is very high or very low.

Find two plants that could grow in your soil conditions.

L10: TEACHERS' GUIDE

Activity 1 answers:

1. T
2. F
3. T
4. T
5. F
6. F
7. T

Activity 2:

Pre-experiment preparation:

Before class, collect soil samples from two sites and record where you collected them from. Be sure to note what the land is used for (e.g. gardening, tilled field, construction site, etc.) and the exact location. You should have enough soil from each site that each group can analyse both sites.

NOTE: You can spread this lesson over two lessons, or in the account of a longer lesson, and have learners collect soil samples from two sites per group using the collection instructions in Lesson 7. Have each group analyse their soil samples.

Make sure the pH metres are properly calibrated. See video: Calibrate a pH meter in media box. Be sure to read your metre's instructions as every brand may be different.

SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 11: Soil Chromatography Preparation

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil Chromatography Preparation

In this lesson, we delve into the world of soil analysis, shedding light on the critical role soil plays as a natural resource for both human health and ecosystems. We will get acquainted with the techniques needed and prepare to explore soil components and its interactions, through a paper chromatography experiment. This lesson focuses on providing an introduction to chromatography as well as serving to prepare all the materials needed for the hands-on experiment.

Vocabulary: Capillary forces, Porosity, Solubility

In this lesson, the learner will:

- learn the basics of chromatography and how it can be used to analyse a soil sample.
- prepare an experiment to visually appreciate soil composition.

Materials:

- Worksheet: chromatography preparation
- Teachers' Guide
- AgNO3 and NaOH
- Cardboard or A4 white papers,
- Coffee filters (must be acid-free paper) or chromatography papers
- Dark room or a box per learner/group,
- Distilled water
- Gloves and goggles for all
- Jars with lid / beaker / container
- Scales
- Petri dishes
- Various Mortars and pestles
- Several sieves
- Various Scissors

MM5: Dig Out the Secrets of Soil
L11: Soil Chromatography Preparation

ACTIVITY INSTRUCTIONS

Activity 1: Introduction (10 minutes)

1. Show the video Soil Chromatography, CSUC/CEDECO [4:54min]. Stop the video at 4:39min.
2. As learners are watching the video, have them take notes on the instructions.
3. Discuss as a class.

NOTE: In the video, the person swallows a solution at 4:39min. Please stop the video before this time as to not encourage learners to swallow the solution. Remind learners about lab safety emphasising that we never taste anything in the lab and we do not directly smell anything in the lab.

Activity 2 requires preparation in advance of the class. Please see the teachers' guide.

Activity 2: Soil Chromatography Preparation (40 minutes)

1. Distribute Worksheet: chromatography preparation and distribute all the material: the reagents, jars and lids, petri dishes, filters, etc. explain that some are to be shared (e.g. mortars, scissors, etc.).
2. Go through the instructions with the learners and emphasise that they should use protective equipment (gloves, goggles, etc).
3. Have learners complete Worksheet: chromatography preparation.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L11: Soil Chromatography Preparation

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, remove Activity 1. Precut the coffee filters as circles and wicks to speed up the preparation process.

Extension: For a longer class, have learners collect their own soil samples using the soil collection instructions from Lesson 7. If your learners are at the stage of mixing their own solutions, have the learners mix the NaOh or AgNO3 solutions.

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Soil Chromatography, CSUC/CEDECO
[4:54min] https://www.youtube.com/watch?v=VLqD9CEewx8&list=PLSfsUDrR_Mt17V-qrdyRWYpZhoQk3t_Cn&index=3&ab_channel=QuintinTroester

Paper & Thin Layer Chromatography | Chemical Tests | Chemistry | FuseSchool (4:01)
https://www.youtube.com/watch?v=ByJ6lzD2Vbg

Eugenio Gras on biofertility & chromatography [3:55min] https://www.youtube.com/watch?v=QU7gH3ZeGnY&list=PLSfsUDrR_Mt17V-qrdyRWYpZhoQk3t_Cn&index=3&ab_channel=LearnPermaculture

Portraying Soils and Compost: Color, Form, and Pattern
https://www.natureinstitute.org/article/bruno-follador/portraying-soils-and-compost

Using paper chromatography for assessing soil health https://torbaycatchment.org.au/wp-content/uploads/2019/07/Using-paper-chromatography-for-assessing-soil-health-compressed-1.pdf

Soil chromatography https://kitondaatjerolls.com/SOIL-CHROMATOGRAPHY

[Day 4] Soil Chromatography Workshop https://forum.openhardware.science/t/day-4-soil-chromatography-workshop/1512

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Interview local organic and holistic farmers to see if they have used this experiment to test their soil. If so, what did they find? What did it tell them?

L11: CHROMATOGRAPHY PREPARATION

Paper chromatography of soil extracts is an analysis used by holistic farmers all over the world. It is a visual method for portraying soil health and how 'alive' the soil is.

In the next lesson, you will conduct the chromatography experiment. First, we need to prepare for the experiment.

Equipment needed

100ml 1% NaOH
5ml at 0.5% AgNO3
Cardboard or A4 white papers,
Coffee filters (must be acid-free paper) or chromatography papers
Dark room or a box per learner/group
Distilled water
Gloves and goggles for all
Two jars with lid / beakers / containers
Scales
Two petri dishes
Mortar and pestles
Sieve
Scissors

*** Use gloves and goggles throughout the sample preparation process.**

Your teacher will give you two soil samples and tell you their location. Write down their location:

Sample 1:_____

Sample 2:_____

Take two beakers or cups and label them 'group name' and 'sample 1' / 'sample 2'.

Using a mortar and pestle, take the first soil sample and grind it up until the soil is very fine and there are no lumps in it.

Use a 2mm sieve to ensure the soil is very fine.

Measure 5 grams of the ground up soil and place into the beaker labelled 'sample 1'.

L11: CHROMATOGRAPHY PREPARATION

Add 50mL of 1% NaOH to soil sample 1 in the jar and mix for one minute.

Repeat with soil sample 2.

Set this aside, and you are going to prepare the filter paper with the reagents.

Please note: AgNO3 is a strong stain and can cause skin irritations. Keep the filter papers clean. This step should be done with gloves and in a dark environment so close the blinds on the windows, ensuring you can still see what you are doing.

Cut two big circles from the coffee filters or chromatography paper.

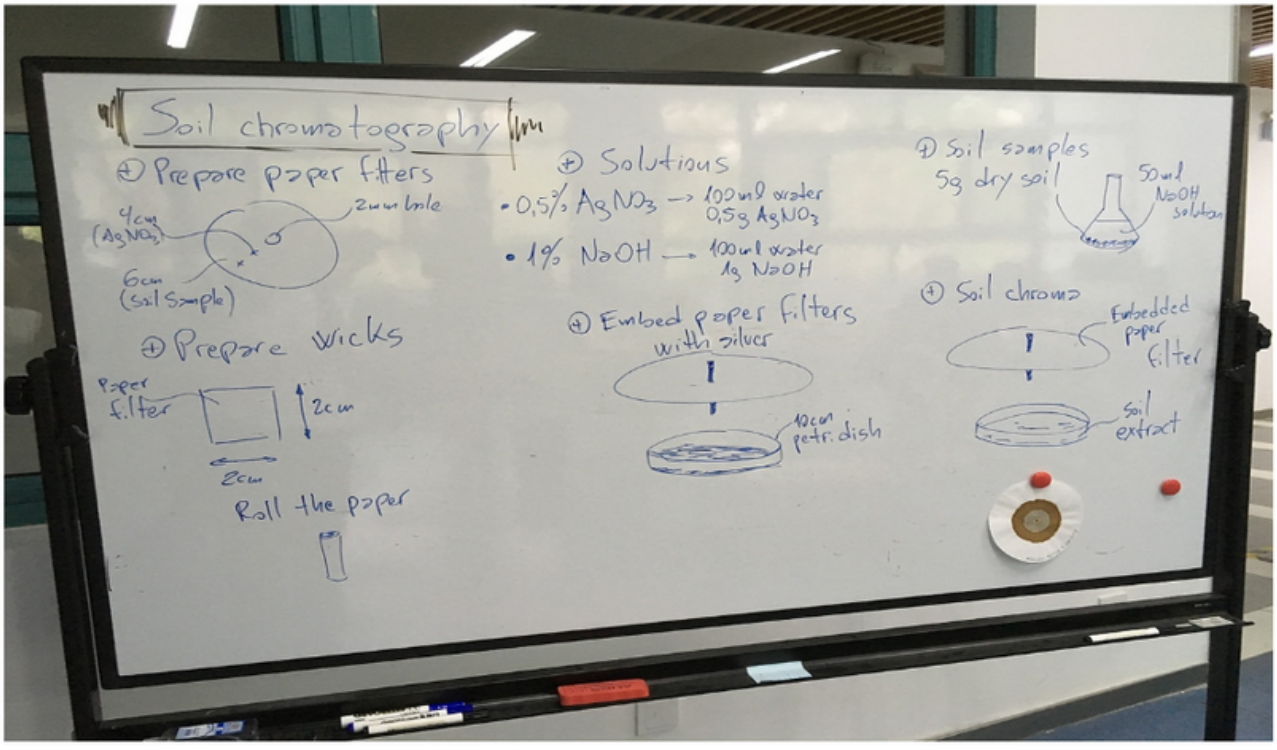
Make a small hole in the centre of each circle you just cut.

Use the rest of the filter / paper that you did not use in the circle to make two small tubes (wicks) of 2-3 cm.

Put a wick into holes you made in both of the circles.

See photo below for guidance.

At this stage, mix both of your soil solutions again.



Small resume of the process based on RESTREPO RIVERA, J. R; PINHEIRO, S. Cromatografía – Imágenes de vida y destrucción del suelo. Juquira Candiru Satyagraha, 2011. (Picture by Rachel)
https://forum.openhardware.science/t/day-4-soil-chromatography-workshop/1512

L11: CHROMATOGRAPHY PREPARATION

Take two petri dishes and add 2mL of 5% $AgNO_3$ to each petri dish.

Place the circles (with the wicks) into the solution ensuring that only the wick is in contact with the $AgNO_3$.

Wait about 15 minutes until the paper has absorbed the solution at least until 1cm away from the edge of the paper.

Lift the circle out and remove the wick.

Bring your circles to your teacher to place in a dark environment until next class. When you place the circles, be sure to have a paper towel under your circles. If you stack the circles in box, have paper towels between each circle.

At this stage, mix your soil solutions again. Cover them with a lid and leave in a safe place for next class.

L11: TEACHERS' GUIDE

Pre-experiment preparation

Before class, collect soil samples from two sites and record where you collected them from. Be sure to note what the land is used for (e.g. gardening, tilled field, construction site, etc.) and the exact location. You should have enough soil from each site that each group can analyse both sites. Each group needs about 5 grams of each soil sample.

NOTE: You can spread this lesson over two lessons, or in the account of a longer lesson, and have learners collect soil samples from two sites per group using the collection instructions in Lesson 7. Have each group analyse their soil samples.

Prepare individual solutions of 50ml 1% NaOH for each group for each of the soil samples (e.g. each group will need 100ml 1% NaOH for two soil samples). To mix the solutions, disisolve 10g NaOH in 1 l of distilled water and stir generously until the salt is dissolved. Then prepare small containers for each group.

Prepare individual solutions of 5ml at 0.5% $AgNO_3$ for each group. To mix the solution, dissolve 0.5g $AgNO_3$ in 100ml of distilled water. Then prepare small containers for each group.

NOTE: If your class has worked with chemicals before, or at the stage where they can mix their own NaOH and $AgNO_3$, have the learners do this in class.

During class:

1. Require that learners use gloves and lab glasses/goggles. And Instruct them on the safety and good practices of a lab experiment.
2. Ensure that all materials are properly labelled: containers (NaOh or $AgNO_3$ solution, person/group name) and circular filters (e.g. Person/Group name, Sample #) so that owners can identify them in the next lesson.
3. Make sure all is stored in the darkest environment possible otherwise the sun can cause the components to change and the result might not be as desired.
4. For the disposal of AgNo3 solution we should add NaCl first to neutralise it because Ag is poisonous.
5. Ensure that the circles and soil samples are properly stored for the next class.

SDG 15 Seeding Sustainability
MM5: Dig Out the Secrets of Soil

MM5: Dig Out the Secrets of Soil

Experimentation and Exploration

Lesson 12: Soil Chromatography Experiment

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil Chromatography Experiment

In this lesson, we look at the intriguing world of chromas, captivating and intricate images that unveil the hidden beauty and complexity of soil composition. This method allows us to capture a soil sample's essence on paper, creating unique pieces of art that reflect the soil's composition and the bustling microcosm within it.

Vocabulary: Biodynamic, Chroma, Supernatant, Solution

In this lesson, the learner will:

- obtain and interpret results (chromas) of a chromatography experiment using soil.
- consider the differences in soil health visually and defend its view critically.

Materials:

- Worksheet: Chromatography
- All the materials produced in lesson 11
- Petri dishes
- Pipettes
- Coffee filters or chromatography paper
- Scissors

MM5: Dig Out the Secrets of Soil
L12: Soil Chromatography Experiment

ACTIVITY INSTRUCTIONS

Activity 1: Experiment and Analysis (50 minutes)

1. Learners should get into their groups from Lesson 1.
2. Hand out Worksheet: chromatography and have learners complete the pre-experiment questions.
3. Discuss as a class.
4. Have learners retrieve their circles and soil samples from Lesson 11.
5. Have learners follow the instructions to complete the experiment and record their information on the worksheet: chromatography.
6. Have learners complete the post-experiment questions on the worksheet: chromatography.
7. Discuss as a class.
8. Allow learners to take home their soil chromas or display them in the classroom.

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

MM5: Dig Out the Secrets of Soil
L12: Soil Chromatography Experiment

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, have learners complete the pre-experiment and post-experiment questions at home.

Extension: For a longer class, have learners write a blurb for their chroma describing where the soil is from and what the chroma means. They may also point out their favourite features of the chroma. Have learners share with the class, and display the chroma like an art gallery.
Option B: Let the chromas sit for about 10 days and have the learners answer the post-experiment questions after they have dried for 10 days.

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Soil Chromatography, CSUC/CEDECO
[4:54min] https://www.youtube.com/watch?v=VLqD9CEewx8&list=PLSfsUDrR_Mt17V-qrdyRWYpZhoQk3t_Cn&index=3&ab_channel=QuintinTroester

Paper & Thin Layer Chromatography | Chemical Tests | Chemistry | FuseSchool (4:01)
https://www.youtube.com/watch?v=ByJ6lzD2Vbg

Eugenio Gras on biofertility & chromatography [3:55min] https://www.youtube.com/watch?v=QU7gH3ZeGnY&list=PLSfsUDrR_Mt17V-qrdyRWYpZhoQk3t_Cn&index=3&ab_channel=LearnPermaculture

Portraying Soils and Compost: Color, Form, and Pattern
https://www.natureinstitute.org/article/bruno-follador/portraying-soils-and-compost

Using paper chromatography for assessing soil health https://torbaycatchment.org.au/wp-content/uploads/2019/07/Using-paper-chromatography-for-assessing-soil-health-compressed-1.pdf

Soil chromatography https://kitondaatjerolls.com/SOIL-CHROMATOGRAPHY

[Day 4] Soil Chromatography Workshop https://forum.openhardware.science/t/day-4-soil-chromatography-workshop/1512

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Contact a farmer or grower in your area and see if they will allow you to conduct this experiment with soil from their land. Discuss the results with the farmer.

L12: CHROMATOGRAPHY

You are going to create a chroma using chromatography for your soil samples. Before you do the experiment, answer the following questions.

Using this website, how can you tell if your soil is healthy or unhealthy?
https://www.natureinstitute.org/article/bruno-follador/portraying-soils-and-compost

_____
_____
_____
_____
_____

What are the differences in the chroma between healthy and unhealthy soil?

_____
_____
_____

What do you think your chroma is going to look like for both soil samples? Why do you think this?

_____
_____
_____

Now, follow the instructions below to create your chromas.

NOTE: Steps 1-8 should be done in a dark environment so close the blinds on the windows, ensuring you can still see what you are doing.

Equipment needed

Soil samples from last class
Two petri dishes
Circles from last class
Coffee filters or chromatography paper
Scissors

1. Take your soil samples from the last class and give them one last good shake.

2. Take two petri dishes and pipette each soil sample into a separate petri dish to fill the dish half-way.

3. Make sure to know which petri dish is sample 1 and which petri dish is sample 2.

L12: CHROMATOGRAPHY

4. Take your circles that have soaked in the AgNO3 and label one sample 1 and label the other sample 2.

5. Take the old wicks out and replace them with new wicks.

6. Place the circles with the new wicks in the petri dishes with your soil solutions in them ensuring that only the wick is touching the solution. Make sure you put the circle labelled sample 1 into the petri dish with the sample 1 solution, and the circle labelled sample 2 into the petri dish with the sample 2 solution.

7. Let the solutions soak into the circles for about 15 minutes until the solution reaches about 1 cm from the edge of the circle or when the image does not change anymore.

8. Remove the circle from the solution and take out the wicks.

Now, open the window blinds and let the light come into the classroom. Let your chromas dry for about 15 minutes.

NOTE: Typically we want to leave the chromas to dry for about 10 days, however, we will shorten this time for the purpose of this lesson.

Look at your chromas for each soil sample and answer the following questions:

Draw each of your chroma and label the four zones:
The centre
The inner ring
The outer ring
The edge

SAMPLE 1

L12: CHROMATOGRAPHY

SAMPLE 2

Look at each zone and decide if there is a lot of interaction between the zones (lots of peaks and bleeding between the zones) or very little interaction between the zones (e.g. distinct zones). Keep in mind that the chromas vary in their characteristics depending on soil quality. Separate zones with little interactions signal poorer quality soils, while complex and interacting patterns usually link with soils of a higher quality.

Sample 1:

Sample 2:

How many zones do you see in your two chromas? Do the two soil samples have a similar number of zones?

L12: CHROMATOGRAPHY

Each zone represents a different characteristic. The first zone, the centre, shows the humus (dead material) content and microbial activity of the soil. The inner ring shows the mineral balance and availability of the soil. The outer ring shows the oxidation-reduction potential and pH of the soil. The edge shows the water-holding capacity and structure of the soil.

Using the photo and analysis below, analyse your chromas in a similar manner.

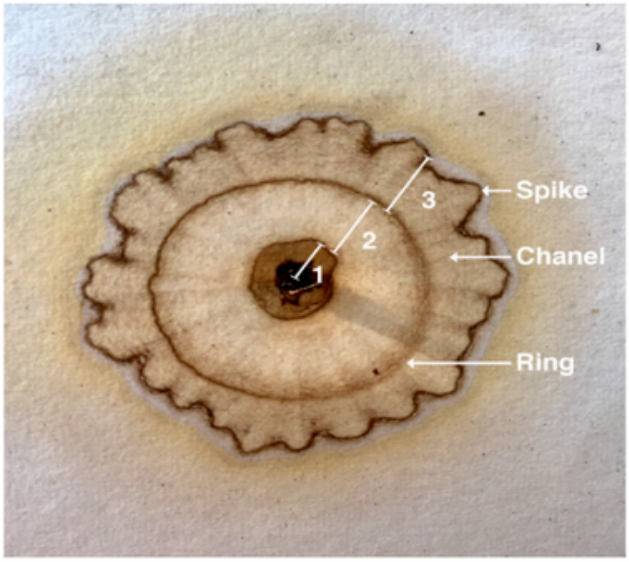


Image 16. A chromatogram that indicates fertile soil. 1. Inner zone with heavy material such as minerals. 2. Middle zone with lighter material such as organic humus. 3. Outer zone with the lightest material such as enzymes and proteins, indicating microbial life.

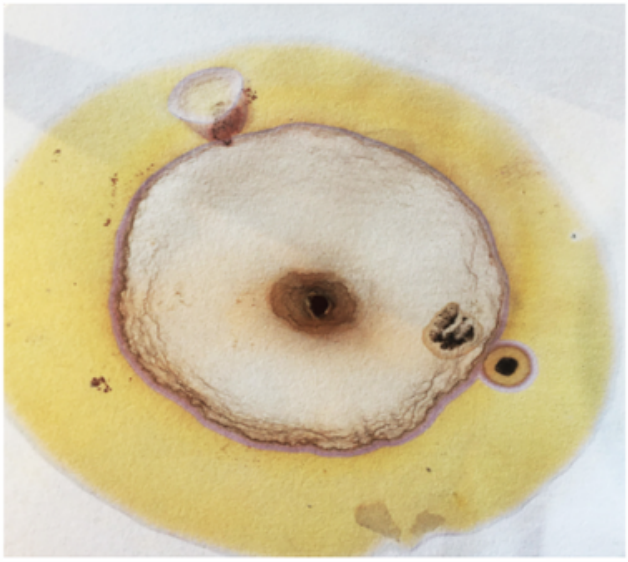


Image 17. A chromatogram that indicates less fertile soil. The urban farmers discussed if the purple line was toxic lead, concluding that the it was more likely traces from bacteria, since it was in the outer circle and heavy lead would likely develop in the inner circle (the outer yellow zone is pure silver nitrate without soil sollution).

From: Relating to Soil: Chromatography as a Tool for Environmental Engagement (acm) https://dl.acm.org/doi/pdf/10.1145/3532106.3533503

Two possible chromas examples:

Chromatogram 1 (image 16): Excellent Humified Compost

- Outer Circle: This chromatogram resembles an iris, with a light-beige outer circle radiating outwards.
- Spike-Like Formations: Spike-like formations penetrate this outer layer, each ending with brown spots, akin to the brown ring in the other figure.
- Main Disc: The inner main disc features brownish hues instead of violet and is filled with feather-like radiations.
- Interaction: Unlike image 17, here, every region harmoniously relates to and interpenetrates the others, creating a sense of movement, development, and harmony.

L12: CHROMATOGRAPHY

Chromatogram 2 (image17): Anaerobic and Stagnated Soil

- Outer Ring: A striking dark, greyish ring encompasses everything, suggesting a sense of enclosure.
- Brown Ring: Inside this boundary, there's a thick, irregular, brown ring, almost an inch thick, appearing somewhat discordant.
- Large Violet Disc: Dominating the figure is a large violet disc, with a smaller violet disc at the very centre. These zones seem rather isolated.
- Interaction: There's minimal interaction between these regions, except for some protrusions extending from the brown ring into the greyish outer belt. Overall, it gives a feeling of stagnation.

These chromatograms illustrate the strong differences in soil quality and soil health. Chromatogram 1 represents healthy, well-aerated, and humus-rich soil with vigorous interactions among soil components, while chromatogram 2 shows a soil with poor aeration, limited organic matter, and stationary processes, indicative of soil degradation. These interpretations can help you understand how chromatography can be used to assess soil quality qualitatively.

Now your turn!

Sample 1 analysis:

_____
_____
_____
_____
_____
_____

Sample 2 analysis:

_____
_____
_____
_____
_____
_____

L12: CHROMATOGRAPHY

Which soil sample do you think is healthier? Why? Does this match your prediction from before the experiment?

What suggestions would you give a farmer or grower for each of your soil samples (e.g. conduct a further test of nitrogen, phosphorus and potassium, increase humus matter with compost, etc.)?