Module 3: Soil Science & Soil Health

Module 3 Quiz Answers and Grading Rubric (Full)

Quiz Administration Instructions

1. Quizzes are aligned to each of the three module lessons (A, B, C). Administer them after completing the corresponding lesson or use it as a cumulative exam.
2. Questions are a mix of multiple-choice, short-response, true/false, short-essay, and design-based prompts.
3. Provide students with 20-25 minutes per quiz, depending on question type and depth. Can be tailored depending on how long each presentation takes.
4. Use student responses for formative assessment and discussion prompts in class.
5. Consider a group review of answers after submission to promote peer learning and reinforce content.
6. Lesson A short response and short essay do not have key words to lookout for, making it easier for students to gain points early on. Lesson B and C DO have key words to look out for, and should be more specific and detailed with their answers.

Question-Based Suggestions

1. The short essay questions are optional for the instructor to use and can be administered based on expectations.
2. True or false questions can be bonus questions or a normal question, depending on how much time the instructor has allotted for each quiz.
3. The design question should ideally be a requirement, since it should be encouraged to provide an assignment that can use critical thinking and problem solving, especially at the end of the module.
4. The design question can be an open note activity.
5. If the instructor decides to do a review of answers after submissions, encourage students to explain why incorrect answers were incorrect for participation.

Grading Rubric

Use this expectations rubric to assess short response, short essay, and design-based responses:

Criteria	**Exceeds (3 pts)**	**Meets (2 pts)**	**Needs Improvement (1 pt)**
Content Accuracy	Response demonstrates deep understanding with specific examples and accurate terminology.	Response addresses the question with mostly accurate content.	Response contains inaccuracies or lacks sufficient explanation.
Clarity & Organization	Response is clearly organized and easy to follow.	Response is mostly clear with minor lapses in structure.	Response is disorganized or difficult to interpret.
Use of Evidence/Data	Provides clear evidence or references to concepts discussed in class/maps/resources.	Some supporting detail or evidence is provided.	Little or no supporting evidence included.
Creativity/Insight (for design prompts)	Innovative, thoughtful, and feasible solutions with clear logic.	The solution is appropriate and meets basic requirements.	Lacks originality or feasibility; vague or incomplete solution.

Lesson A Quiz – Soil Fundamentals
QUIZ LINKS:

[Module 3 Lesson A Quiz - Editor Link]
[Module 3 Lesson A Quiz - Responder Link]

Multiple Choice

Select the correct definition of “soil health”:

A. Soil health means the amount of fertilizer a soil can hold before nutrients are lost.
B. Soil health means the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.
C. Soil health is the ability of soil to grow crops without adding any outside inputs
D. Soil health is the natural color, texture, and smell of the soil that shows if it is fertile.

What is the difference between soil and dirt?

A. Soil contains structure and has pores; dirt is soil that is out of place.
B. Soil is sterile, while dirt contains living microbes.
C. Soil is found only in farms, while dirt comes from urban or construction areas.
D. Soil is rich in sand, while dirt is made mostly of clay and silt.

Why is it important for soil aggregates to create pore space?

A. Allows roots to avoid soil organisms that might damage them.
B. Prevents rainfall from entering too quickly and drowning plants.
C. Air and water move around, roots can breathe, and microbes can thrive
D. It keeps soil particles from sticking together permanently.

Decrease in erosion means ____ in infiltration.

A. Increase
B. Decrease
C. No change
D. More runoff

Why is maximizing biodiversity above important for below?

A. It makes plants grow taller so they shade out weeds.
B. It keeps soils cooler by preventing direct sunlight.
C. It increases nitrogen fertilizer efficiency for crops.
D. There is a decrease in pest and disease and increase in cycling, making steadier profits.

When there is healthy soil, water infiltration ___ increases, and erosion/runoff ____.

A. Decreases, increases
B. Increases, decreases
C. Stays the same, decreases
D. Decreases, stays the same

If soil is too alkaline…

A. Plants will have excess phosphorus and potassium.
B. Plants will show symptoms of nitrogen toxicity.
C. Plants will have a Fe/Zn deficiency.
D. Plants will grow faster but produce fewer seeds.

True or False

There are three soil textures: sandy, silty, and fine.

False

Short Answer

Why is healthy soil important for both plants and the environment? Include at least two reasons in your answer.

Answer should:

- Explain at least two reasons why healthy soil is important.
- Include how soil health affects both plants (growth, nutrients, roots) and the environment (erosion, infiltration, biodiversity).
- Be a minimum of 2-3 sentences.

Sample Answer (Exceeds): Healthy soil is important because it allows water to infiltrate instead of running off, which reduces erosion. It also provides air and nutrients so roots and microbes can thrive, helping plants grow better.

Short Essay

Explain how soil health affects water movement, erosion, biodiversity, and nutrient availability. In your answer, discuss why soil is more than just “dirt” and how healthy soils support both plants and the environment.

Answer should:

- Describe how healthy soil improves water infiltration and reduces erosion.
- Explain how biodiversity above and below ground supports plant growth, pest control, and nutrient cycling.
- Discuss the difference between soil and dirt, emphasizing soil’s structure and living ecosystem.
- Mention the importance of nutrient availability (e.g., Fe/Zn deficiency if soil is too alkaline).
- Be at least 4-5 sentences in length minimum, with specific examples from the prompt.

Sample Answer (Exceeds): Healthy soil is very important because it helps water soak into the ground instead of running off. This decreases erosion and keeps the land more stable. Dirt, on the other hand, is just soil that has lost its structure and is out of place, so it cannot support plants the same way.

Soil health also supports biodiversity both above and below ground. When many organisms are present in the soil, they help recycle nutrients, break down organic matter, and keep pests and diseases under control. This makes farming more reliable and can lead to steadier profits.

Nutrient availability is another part of soil health. For example, if soil becomes too alkaline, plants may suffer from iron or zinc deficiencies. Overall, healthy soil functions as a living ecosystem that sustains plants, animals, and humans by providing structure, air, water, and nutrients.

Relevant Vocabulary for short essay/response (Lesson A):

- soil health
- soil structure
- Infiltration
- erosion
- runoff
- biodiversity
- microbes
- roots
- nutrients
- dirt

Lesson B Quiz – Carbon in Soils
QUIZ LINKS:

[Module 3 Lesson B Quiz - Editor Link]
[Module 3 Lesson B Quiz - Responder Link]

Multiple Choice

From the Build-Maintain-Consume triad for soil carbon, explain “maintain”:

A. Add fresh plant material to soil every season.
B. Stop microbes from decomposing organic matter.
C. Rotate crops to keep soil nutrients balanced.
D. Protect carbon in aggregates and on minerals

What happens to the carbon in the soil-carbon cycle?

A. All of it is locked permanently into rocks and minerals.
B. It dissolves into groundwater and is carried to the ocean.
C. Some C is respired as CO2, or stabilized as soil organic matter
D. It evaporates into the atmosphere as methane.

What is sequestration in the soil-carbon cycle?

A. The increase in stock per year (e.g., CO_2e/ha/yr)
B. The temporary storage of carbon in leaves during photosynthesis.
C. The process of removing nitrogen from the soil and storing it in plants.
D. The ability of plants to use water more efficiently when carbon is stored.

When does soil sequestration of carbon occur? Hint: Recall the build-maintain-consume triad.

A. When build > consume for a long period of time.
B. When consume is greater than build for several seasons.
C. When all microbial activity in soil slows down completely.
D. When soil nutrients run out and decomposition stops.

Which of the following is NOT one of the four soil health principles?

A. Maximize continuous living roots
B. Maximize biodiversity
C. Maximize chemical fertilizer inputs
D. Minimize disturbance

___ soil organic matter = ___ resilience.

A. Less, more
B. More, less
C. Same, same
D. More, more

Why are soils that are too wet not ideal?
A. They prevent any carbon from entering the soil system.
B. They increase N2O emissions.
C. They cause plants to absorb too much oxygen through roots.
D. They reduce the soil's ability to store phosphorus long-term.

True or False

Soil is the largest land carbon pool.

True

Short Answer

How does healthy soil help with carbon sequestration, and what conditions are needed for it to happen?

Answer should:
- Explain what carbon sequestration means in soils.
- Describe how soil carbon can be stabilized (e.g., in aggregates, minerals, or soil organic matter).
- Mention that sequestration occurs when carbon building is greater than carbon consumption over time.
- Be at least 3 sentences.

Sample Answer (Exceeds): Carbon sequestration in soils means storing carbon as soil organic matter instead of releasing it back into the air as CO_2. Healthy soils protect carbon inside aggregates and on minerals, keeping it stable for long periods. Sequestration happens when more carbon is built up than consumed, which requires practices like minimizing disturbance and keeping living roots in the soil.

Short Essay

Explain the role of soils in the carbon cycle. In your answer, describe how the build-maintain-consume triad affects carbon storage, and why healthy soils are important for reducing greenhouse gas emissions.

Answer should:
- Define soil carbon sequestration as the storage of carbon in soils as organic matter instead of being released as CO_2.
- Explain the build-maintain-consume triad:
  - Build = adding organic matter (roots, residues).
  - Maintain = protecting carbon in aggregates and on minerals.
  - Consume = loss of carbon through respiration and decomposition.
- Connect soil health practices (e.g., minimizing disturbance, keeping living roots, maximizing biodiversity) to improved carbon storage and reduced greenhouse gas emissions.
- Be at least 5-7 sentences minimum with clear examples.

Sample Answer (Exceeds): Soils play a major role in the carbon cycle by storing carbon as soil organic matter instead of releasing it into the atmosphere as CO_2.

The build-maintain-consume triad explains how soil carbon changes over time. *Build* refers to adding organic matter from roots, plant residues, and other inputs. *Maintain* is the process of protecting that carbon in

aggregates and on minerals. *Consume* is the breakdown of carbon by microbes, which releases CO_2. Sequestration happens when the building of carbon consistently exceeds consumption.

Soil health practices support carbon storage and help reduce greenhouse gas emissions. Minimizing disturbance, keeping living roots in the soil, and maximizing biodiversity all improve soil structure and stability, which enhances carbon storage. In this way, healthy soils not only support plant growth but also help combat climate change by acting as a major carbon sink.

Relevant Vocabulary for short essay/response (Lesson B):

- soil carbon
- carbon sequestration
- soil organic matter (SOM)
- build-maintain-consume triad
- aggregates
- minerals
- respiration
- decomposition
- greenhouse gas (CO_2)
- soil health

Lesson C Quiz – Living Soils & Ecosystem Services
QUIZ LINKS:

[Module 3 Lesson C Quiz - Editor Link]
[Module 3 Lesson C Quiz - Responder Link]

Multiple Choice

Which is the correct definition of mycorrhizae?

A. Fungal diseases that attack plant roots and reduce growth.
B. Root hairs that form when plants lack enough nutrients.
C. A type of bacteria that fixes nitrogen for legumes.
D. Root extensions for reach, exchange nutrients for carbon

What ratio of C:N do microbes thrive?

A. 24:1
B. 5:1
C. 25:1
D. 50:1

Why is too much nitrogen bad?

A. It prevents photosynthesis from taking place.
B. It causes the soil to turn acidic overnight.
C. There is a rapid breakdown and loss of carbon
D. It makes plants stop absorbing water through their roots.

When bacteria and fungi start decomposition, what happens after?

A. Nutrients are released, N, P, and S are mineralized.
B. Soil becomes sterile and loses all microbes.
C. Organic matter turns directly into fossil fuels.
D. The soil particles fuse into larger rocks.

Microbes in the root zone can produce auxin, cytokinin, gibberellin, which ___:

A. Causes roots to stop growing and shut down.
B. Makes plants produce seeds much more slowly.
C. Increases leaf thickness but decreases root function.
D. Makes roots grow, slow aging, and increase stress tolerance.

How does healthy soil create a healthy planet?

A. By reflecting more sunlight back into the atmosphere.
B. By keeping plants short and reducing wind damage.
C. It is the largest land carbon pool, which stores more carbon than plants and the atmosphere.
D. By making all soil pH neutral no matter the environment.

Which of the following is a soil degradation practice?

A. Salinization.
B. Drip irrigation.
C. Cover cropping.
D. Crop rotation.

True or False

Beneficial microbes produce antimicrobials, prey on pathogens, and compete for resources.

True

Short Answer

Explain how microbes and mycorrhizae help plants grow.

Answer Should:

- Define mycorrhizae and its role in nutrient exchange.
- Explain how microbes in the root zone produce hormones and aid decomposition to release nutrients.
- Connect healthy soil to larger environmental benefits, like carbon storage and supporting the planet.
- Be at least 3 sentences.

Sample Answer (Exceeds): Mycorrhizae are extensions of plant roots that help the plant reach nutrients and water while exchanging carbon with microbes. Microbes in the root zone produce hormones like auxin and cytokinin, which help roots grow, slow aging, and increase stress tolerance. They also decompose organic matter, releasing nutrients like nitrogen, phosphorus, and sulfur. Healthy soil is important for the planet because it stores more carbon than plants and the atmosphere, helping reduce climate change.

Short Essay

Explain how mycorrhizae and soil microbes support plant growth and why healthy soil is important for the environment. Include how microbial activity affects nutrients and the role of carbon-to-nitrogen balance.

Answer should:

- Describe how soil microbes produce plant hormones and release nutrients through decomposition.
- Mention the importance of a balanced carbon-to-nitrogen (C:N) ratio for microbial activity.
- Explain how healthy soil benefits the environment, including carbon storage.
- Be at least 5 sentences minimum with clear examples.

Sample Answer (Exceeds): Soil microbes also help plants by producing hormones like auxin and cytokinin, which make roots grow, slow aging, and increase stress tolerance. They decompose organic matter, releasing nutrients such as nitrogen, phosphorus, and sulfur, which plants can use. Balanced carbon-to-nitrogen ratios in the soil help microbes thrive and maintain this nutrient cycle.

Healthy soil is important for the environment because it stores more carbon than plants and the atmosphere, helping reduce greenhouse gas levels. By supporting both plant growth and carbon storage, soils play a vital role in sustaining ecosystems and protecting the planet.

Relevant Vocabulary for short essay/response (Lesson C):

- mycorrhizae
- microbes
- root zone
- auxin
- cytokinin
- gibberellin
- carbon-to-nitrogen ratio (C:N)
- decomposition
- nutrient release (N, P, S)
- soil health