Module 3: Soil Science and Soil Health

Think-Pair-Share Activity C: Design Minute - Microbe Boosters

Lesson C
Grouping: Pairs or small groups (3–4)
Time: 25–30 minutes

Materials:

- One worksheet per student (or per pair)
- Chart paper or large sticky notes for group sketches
- Markers or colored pencils
- Optional: printed SDG icons or slide reference

Objective:
Students will learn how soil management practices (cover crops, mulch, compost, reduced tillage, vermicompost, biochar) influence microbial activity and measurable soil health indicators (e.g., infiltration, aggregate stability, respiration, bulk density, pH). They will connect these changes to ecosystem services and global sustainability goals (SDGs). Students will evaluate trade-offs, propose a management practice, and defend their design with reasoning and evidence.

Instructions:

1. Each student team selects one soil management practice.
2. On the worksheet/chart paper, sketch or note:
    - The practice chosen
    - Predicted changes in one or more soil indicators
    - The ecosystem service most affected
    - The related SDG(s)
3. Teams participate in a gallery walk, leaving comments/questions on others' designs.
4. Each group defends their design in a short share-out.
5. As a class, synthesize patterns, trade-offs, and connections between soil biology, ecosystem services, and SDGs.

Your Task:
Your task is to design a Microbe Booster Map showing how one soil management practice shifts a soil health indicator and supports an ecosystem service. Then, link your design to a relevant SDG and defend your reasoning.

Step 1: Team Design Minute (Group Work)
Pick ONE practice: Cover crop | Mulch | Compost | Reduced till | Vermicompost | Biochar

Fill in the table:

Practice Chosen	Indicator Prediction (↑ / ↓ / ↔)	Ecosystem Service Impact	SDG Match
Cover crop (legume + grass mix)	Infiltration ↑, Respiration ↑, Bulk density ↓	More stable yields, reduced fertilizer needs	SDG 2: Zero Hunger; SDG 13: Climate Action
Mulch	Infiltration ↑, Soil temperature ↔/↓, Respiration ↑	Cleaner runoff, water conservation	SDG 6: Clean Water and Sanitation

Compost	Respiration ↑, SOM ↑, pH → optimal	Nutrient cycling, reduced chemical fertilizer dependence	SDG 12: Responsible Consumption & Production
Reduced till	Aggregate stability ↑, Respiration ↔/↑ (long-term), Bulk density ↓ over time	Climate mitigation (SOC storage), erosion control	SDG 13: Climate Action; SDG 15: Life on Land
Vermicompost	Respiration ↑, Nutrient availability ↑, Disease suppression ↑	Healthier crops, reduced pesticide use	SDG 3: Good Health & Well-Being; SDG 2: Zero Hunger
Biochar	Bulk density ↓, Infiltration ↑, Respiration ↔ (stable carbon)	Cleaner water, long-term carbon storage	SDG 6: Clean Water; SDG 13: Climate Action

Step 2: Sketch It Out
Draw a quick diagram showing how your practice changes the indicator (arrows up/down, microbes, roots, water movement, etc.).

- Cover crop → roots ↓ exudates → microbes ↑ → glues ↑ → aggregate stability ↑ → infiltration ↑
- Mulch → mulch layer ↓ evaporation → soil temp moderated → microbes ↑ → infiltration ↑
- Compost → organic inputs ↑ → respiration ↑ → nutrient cycling ↑ → SOM ↑
- Biochar → porous particles ↑ pore space → infiltration ↑, bulk density ↓

Step 3: Gallery Walk (Class Interaction)
- Post your group's sketch.
- Rotate to 2–3 other groups. On sticky notes, add:
  - One thing you agree with.
  - One thing you'd tweak or question.

Notes:

- Agreement: "We also predicted that compost would raise respiration and improve SOM. Great diagram of nutrient cycling!"
- Tweak / Question: "Could bulk density also be affected by compost addition over time? Maybe add that in."

Step 4: Share & Defend (Mini-Presentations)
One group member gives a 1-minute defense:
- Why did you pick this practice?

"We picked cover crops because they are widely used and connect easily to both soil biology and SDGs."

- How will it affect microbial activity and soil indicators?

"Roots exude carbon, which stimulates microbes. Microbes build aggregates, so we predict infiltration ↑ and bulk density ↓. More microbial respiration also means more cycling of N and P."

- Which SDG does it connect to and why?

"Cover crops link to SDG 2 (Zero Hunger) by stabilizing yields and reducing fertilizer dependence, and SDG 13 (Climate Action) by increasing soil carbon."

Reflection

1. Which practices had the biggest predicted effects on microbial activity?

- Compost, vermicompost, and cover crops → directly feed microbes.
- Biochar → less effect on respiration, but stronger impact on structure and water holding.

2. Did different teams connect the same practice to different SDGs? What does that show?

- Yes: Biochar linked to SDG 6 (water) and SDG 13 (climate).
- Shows practices have multiple co-benefits depending on perspective (water vs carbon).

3. What trade-offs came up (e.g., high C:N slows decomposition but builds stable aggregates)?

- Rye (high C:N) can immobilize N short-term → trade-off between soil stability and nutrient availability.
- Reduced till improves SOC long-term, but may show slower short-term yield gains.

4. If you were advising a farmer, which combination of practices would you recommend, and why?

- Cover crop + compost → balances quick nutrient cycling with carbon retention.
- Reduced till + biochar → builds long-term soil structure, water regulation, and climate benefits.

Skills You'll Use:

- Systems thinking (linking soil indicators → ecosystem services → SDGs)
- Evidence-based reasoning (using NRCS test data + lesson knowledge)
- Visual modeling (sketches & indicator arrows)
- Collaboration & synthesis (gallery walk + group defense)

Example:

Our team chose biochar. We predicted bulk density ↓ and infiltration ↑, since biochar improves pore space. The ecosystem service is cleaner runoff and better water filtration. We linked it to SDG 6: Clean Water and Sanitation. We defended this by noting that stable carbon in biochar also supports SDG 13 (Climate Action). Other groups added that biochar also affects respiration, showing there are multiple valid connections.