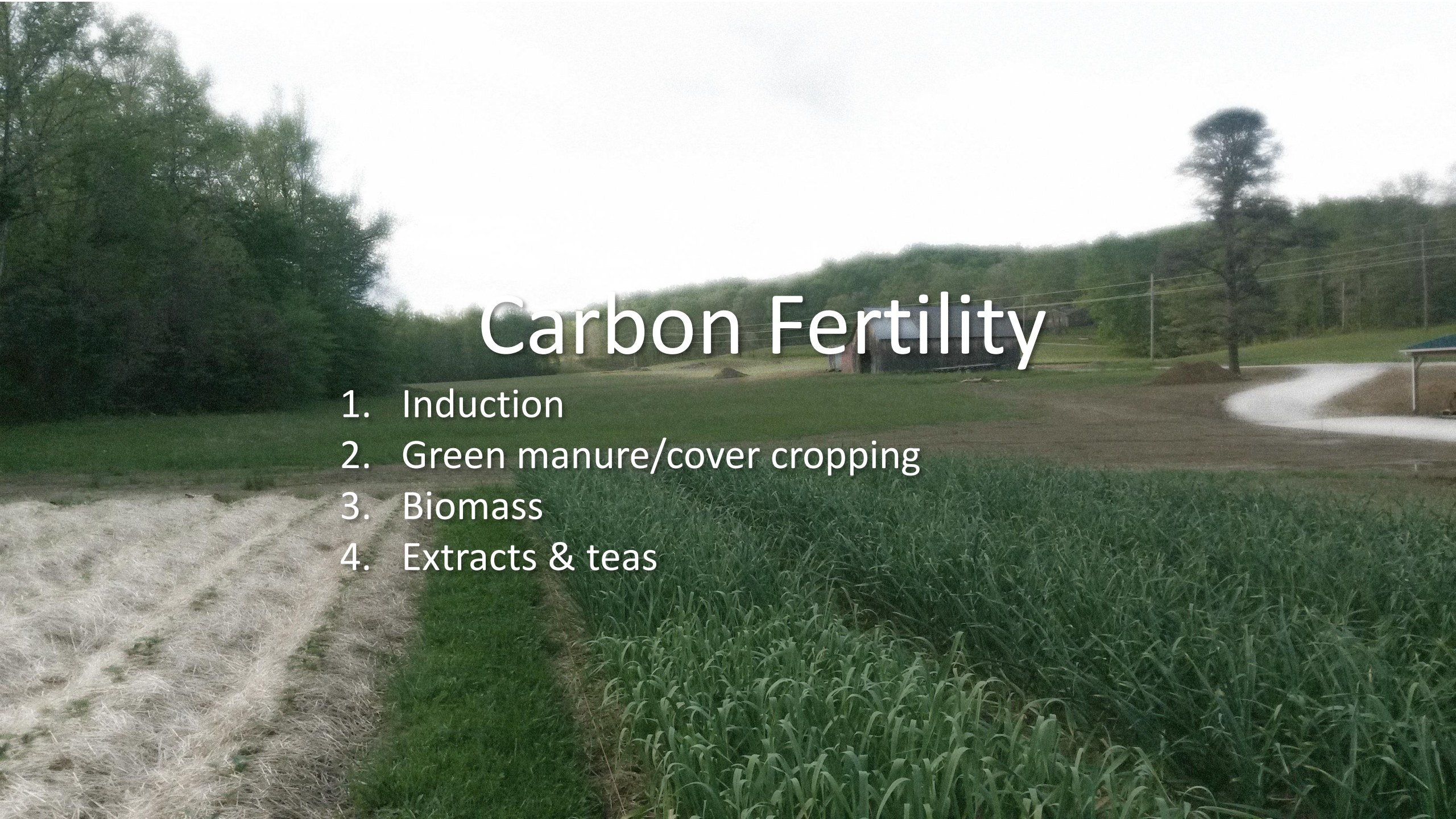
SOIL FERTILITY FUNDAMENTALS

BIOLOGY THE ULTIMATE OBJECTIVE



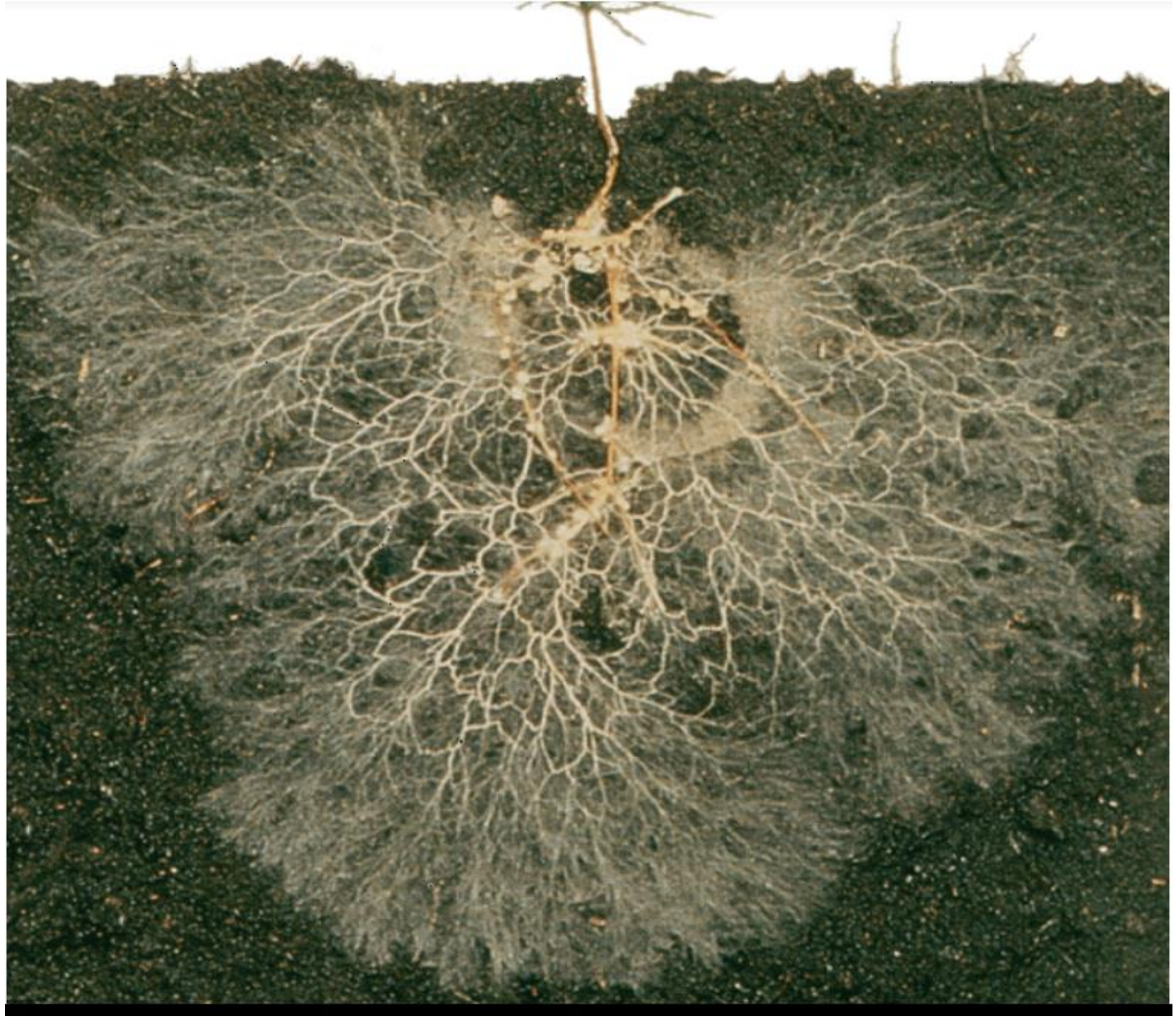
Carbon Fertility

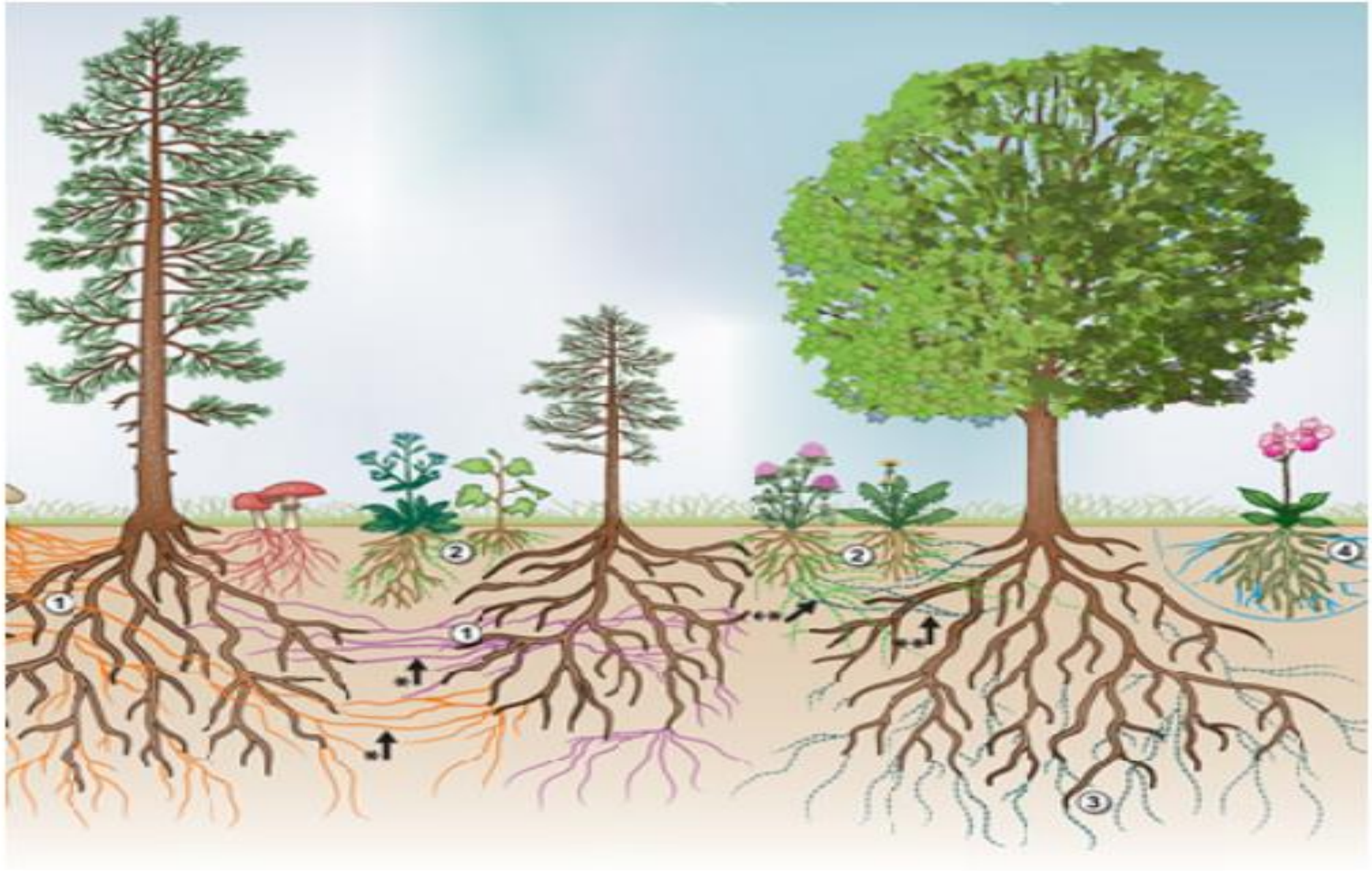
1. Induction
2. Green manure/cover cropping
3. Biomass
4. Extracts & teas

Induction

"The liquid Carbon pathway"

- 1. Full Capacity Photosynthesis – Most crops can produce as much as 3-5 times more photosynthetic energy than they typically do.
- 2. Sugars are released as root exudates. Bacterial Populations develop rapidly to utilize these sugars.
- 3. As bacterial populations develop, they extract minerals from the soil mineral matrix to build their own cells.
- 4. Plants absorb microbial metabolites and become exceptionally energy efficient, resulting in the development of elevated lipid levels.
- 5. Lipids are exuded from the roots and are digested by soil fungal populations, which expand rapidly.
- 6. Fungal digestion of lipids results in the formation of stable humic substances with long half lives.




1
2
1
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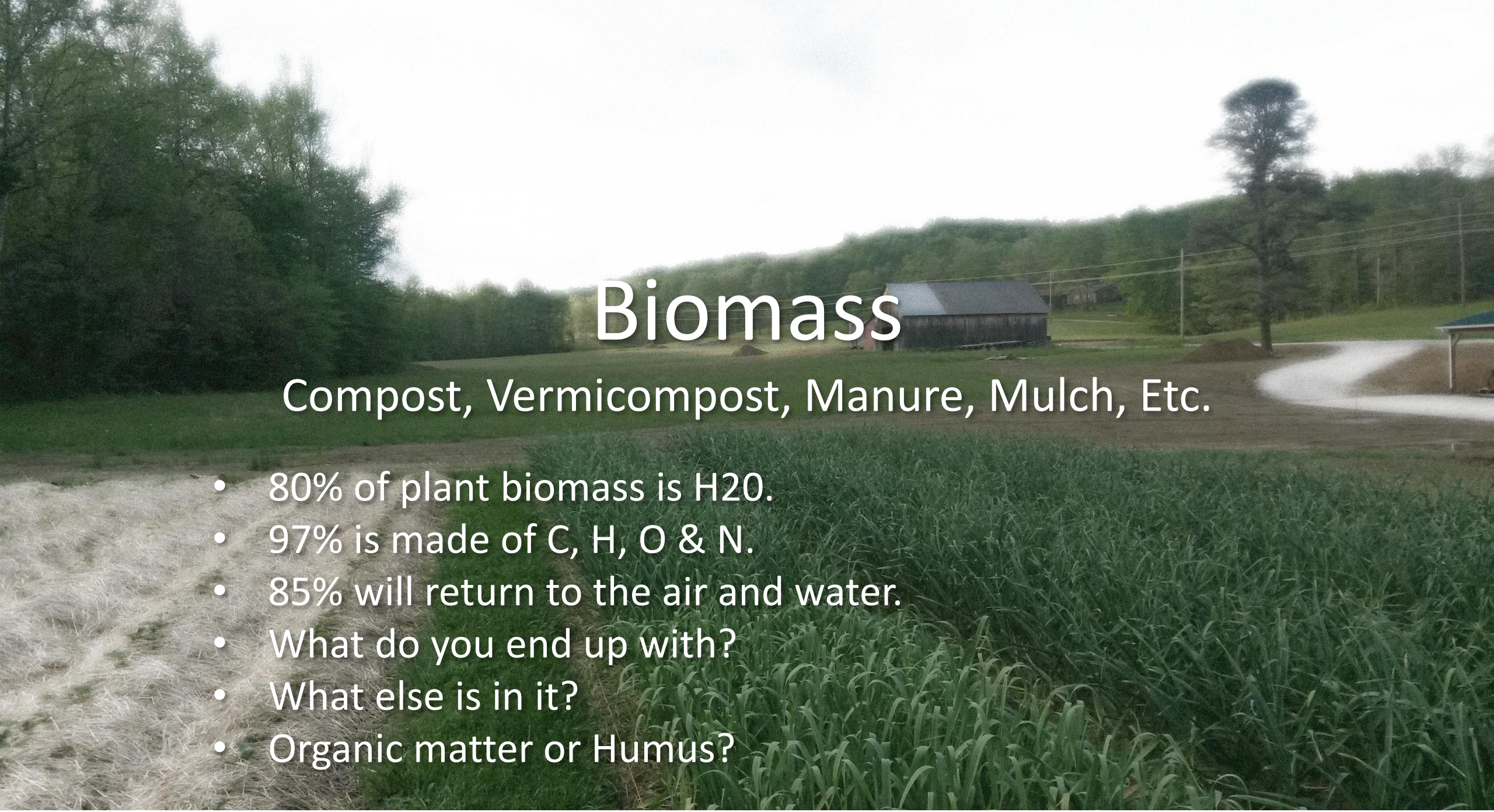
3
4

Green manure/cover cropping

- Strive to keep something growing on the soil at all times.
- Maximize the diversity of plant families.
- Companion planting, inter seeding, over seeding, independent seeding

Helpful information sources: SARE – “Managing Cover Crops Profitably”
Trueleaf Market - Cover Crop Growing Guide
Green Cover Seed – Soil Health Resource Guides



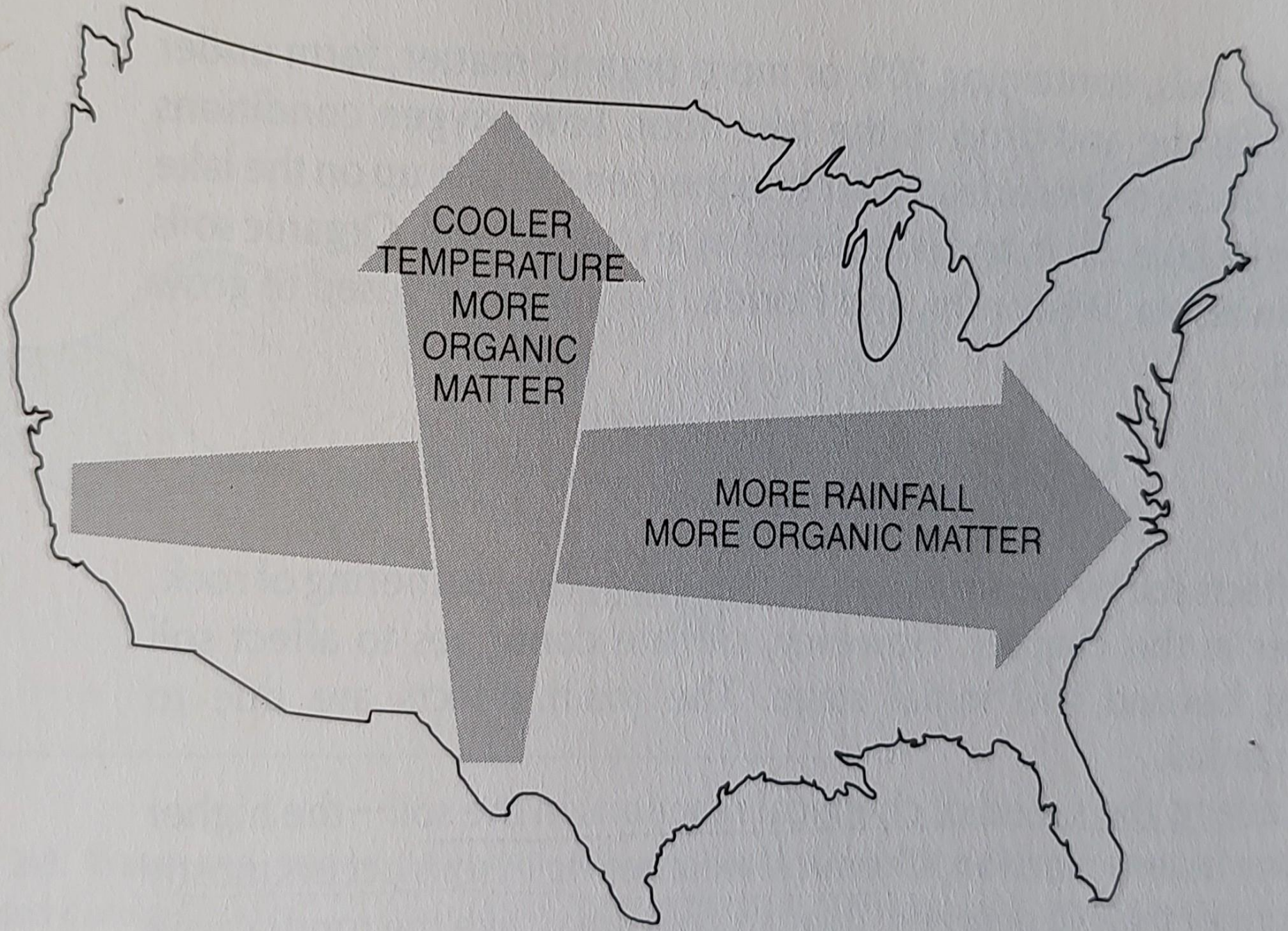
Biomass

Compost, Vermicompost, Manure, Mulch, Etc.

- 80% of plant biomass is H20.
- 97% is made of C, H, O & N.
- 85% will return to the air and water.
- What do you end up with?
- What else is in it?
- Organic matter or Humus?

Extracts and teas

- Bio-stimulation: Signaling, Nutrition
- Bio-inoculation

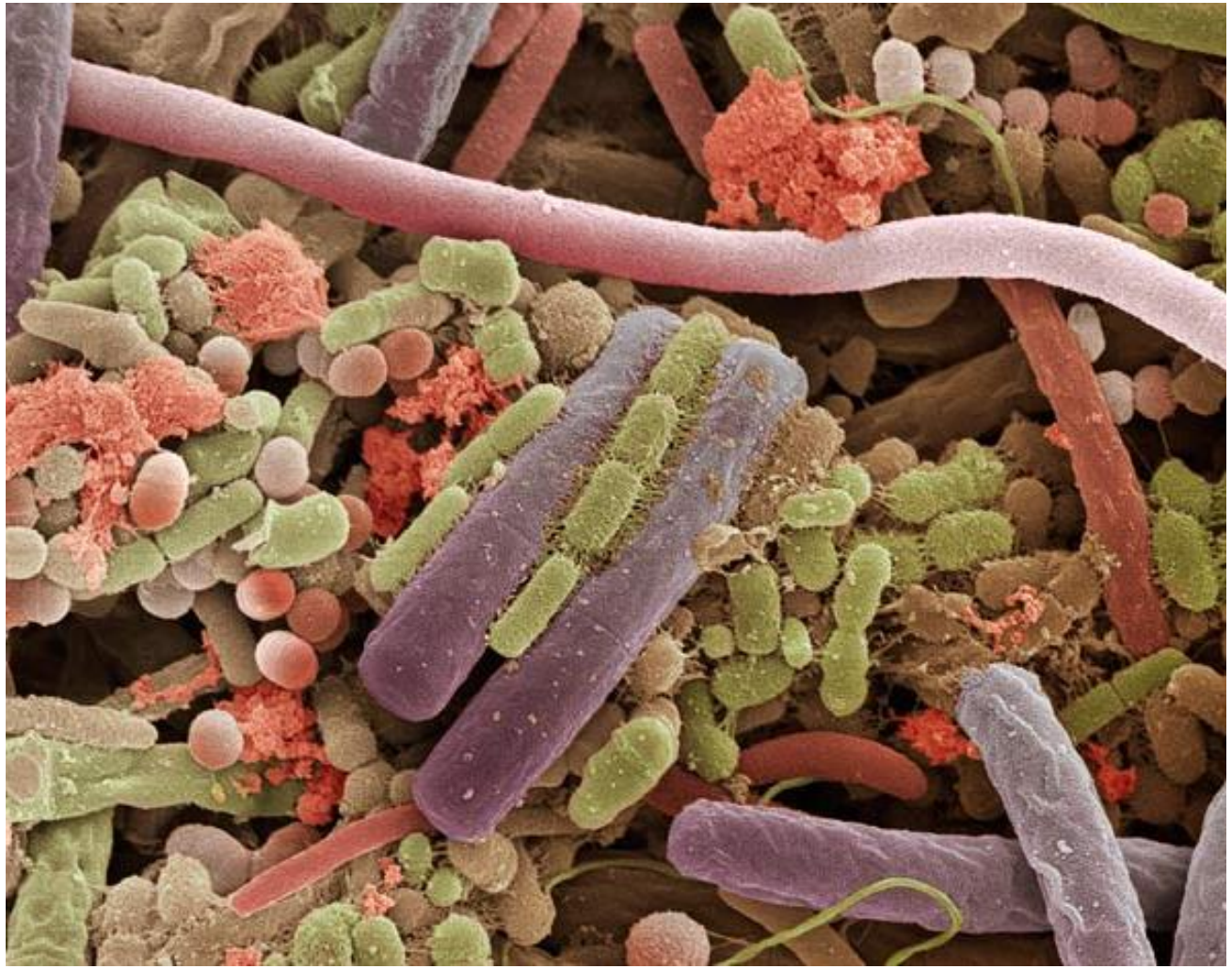

COOLER
TEMPERATURE
MORE
ORGANIC
MATTER
MORE RAINFALL
MORE ORGANIC MATTER

The Soil Food Web

First trophic level:	Second trophic level:	Third trophic level:	Fourth trophic level:	Fifth & higher trophic level:
Photosynthesizers	Decomposing Mutualists Pathogens, Parasites Root-feeders	Shredders Predators Grazers	Higher level predators	Higher level predators

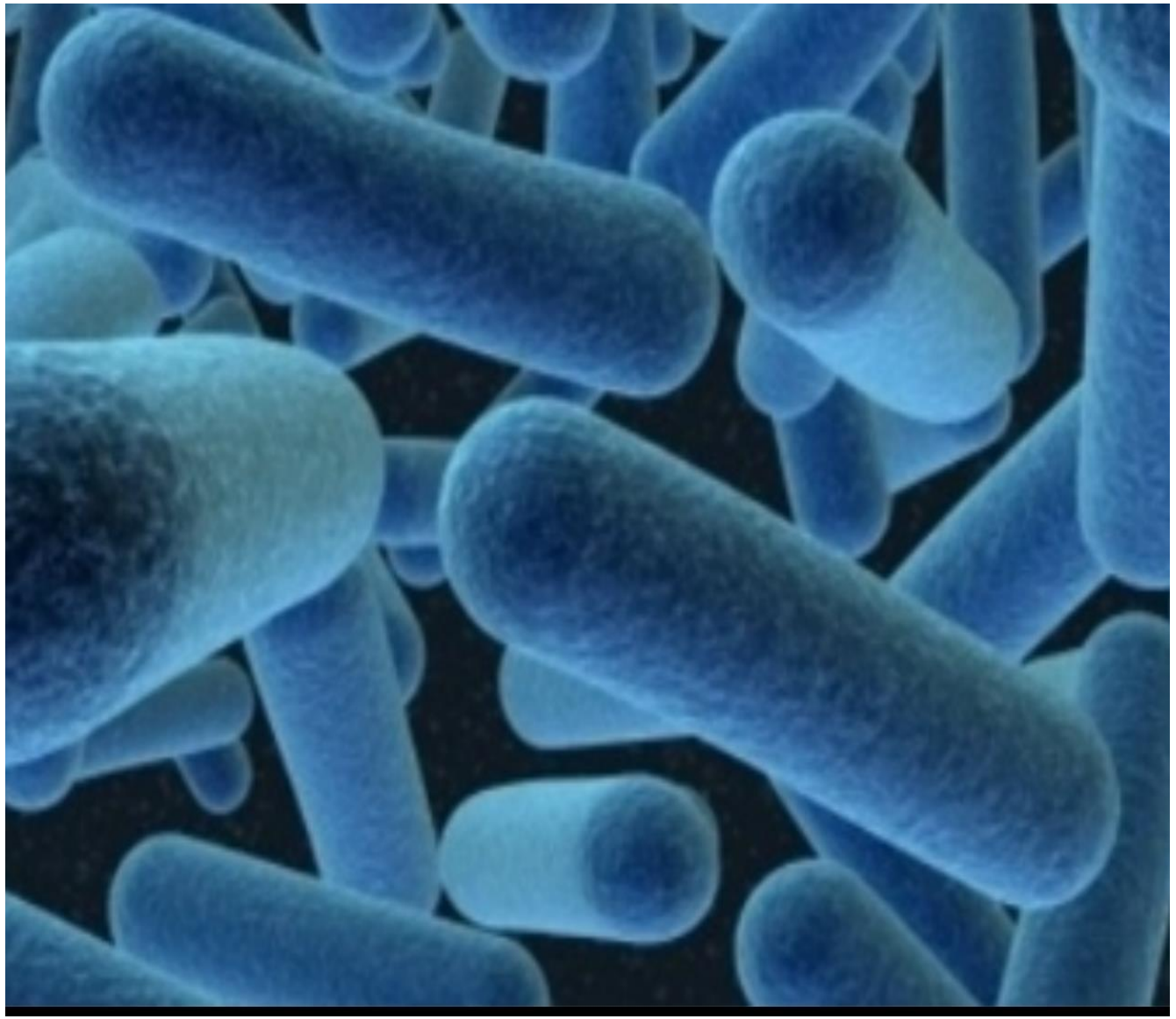
Bacteria

1. Nitrogen fixers (Rhizobium, Azotobacter, Cyanobacteria)
2. Nitrifiers (aerobic)
3. De-Nitrifiers (anaerobic)
4. Decomposers – (Actinomycetes)



Archea

1. Similar functions to bacteria but can live in more extreme conditions.



Fungi

1. Saprophytes
2. Mutualists
   (VAM, Ecto, Ericoid)
3. Pathogenic
   (Pythium,
   Rhizoctonia,
   Phytothora,
   Verticillium)

Protazoa

1. Ciliates
2. Amoebae
3. Flagellates

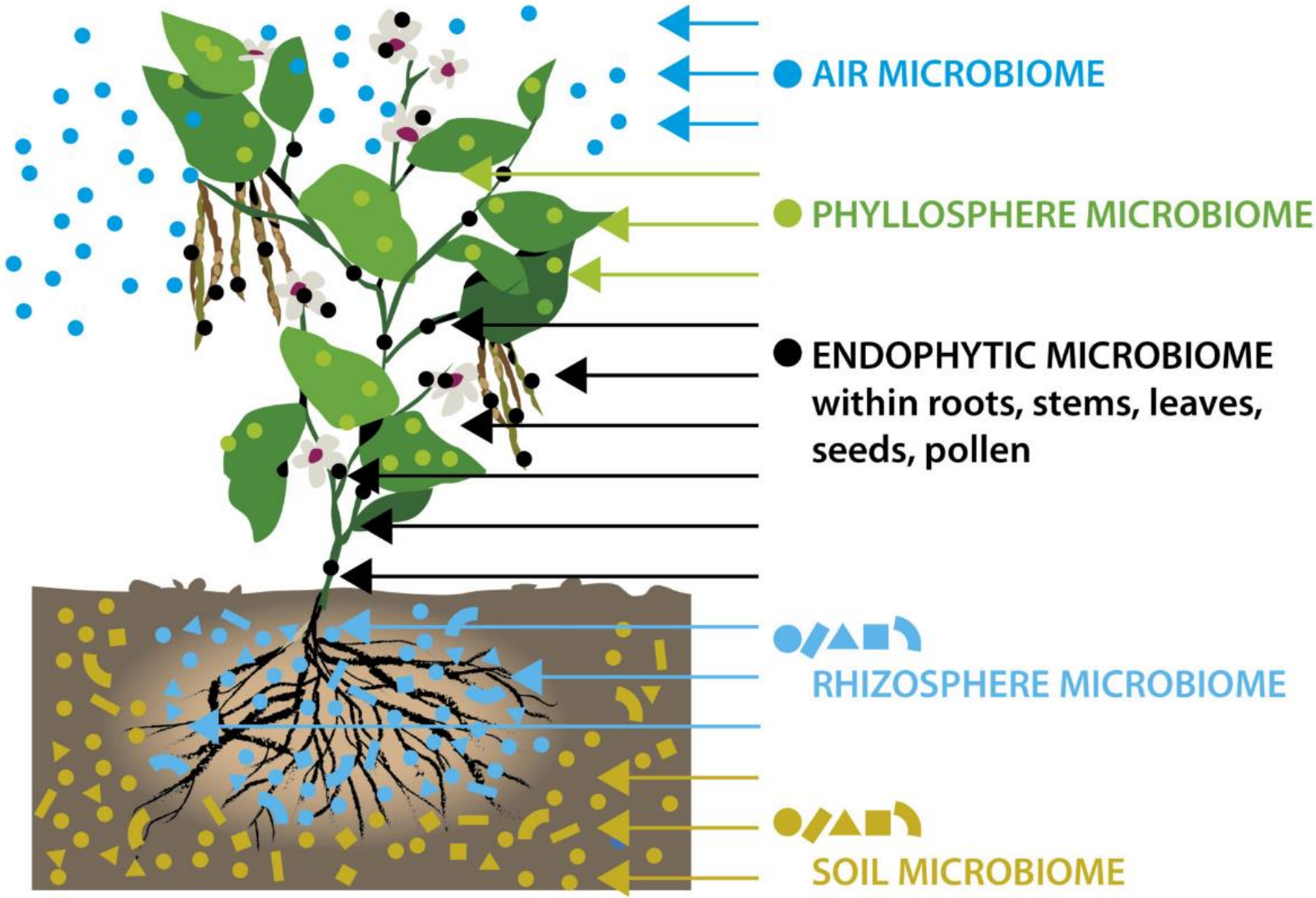
Nematodes

1. Saprophites
2. Predators
3. Parasites

Earthworms

1. Recycling
2. Increase nutrient availability
3. Improve soil structure

THE PLANT MICROBIOME

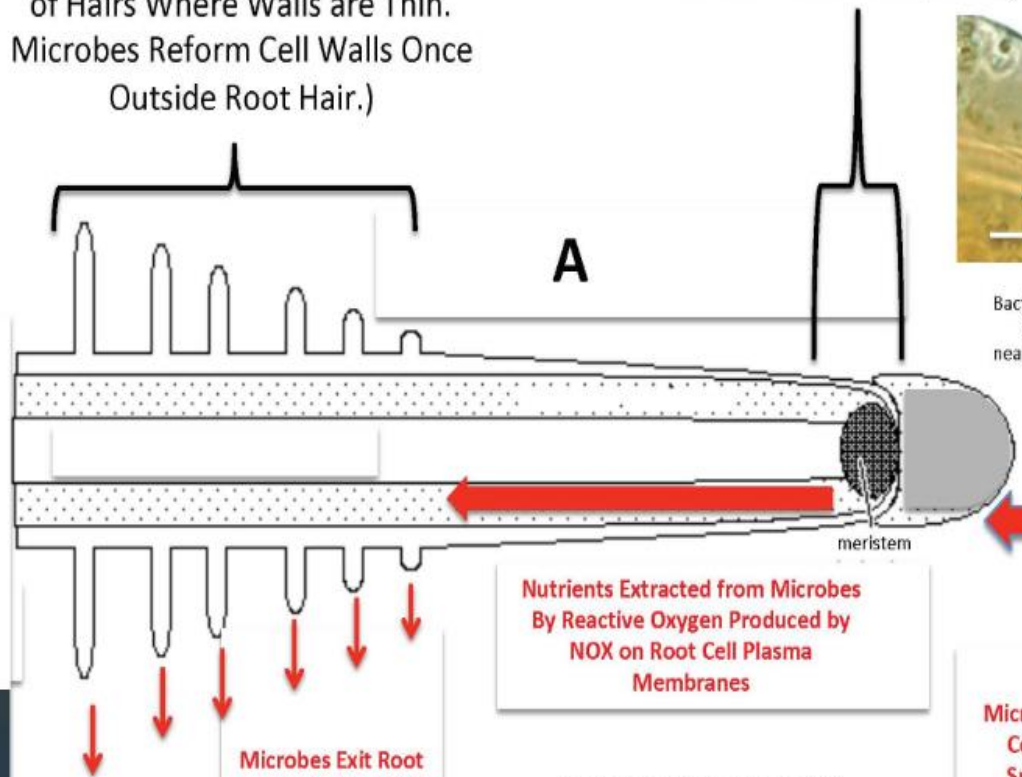


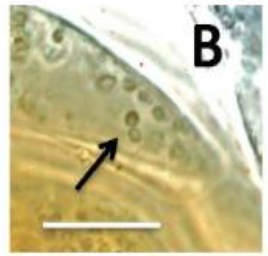

Rhizophagy

1

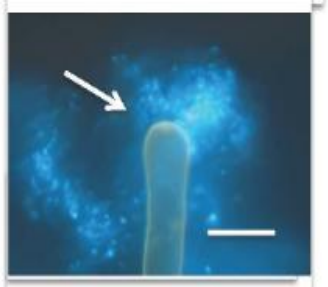
Microbe Exit Zone
(Microbes Stimulate Elongation of Root Hairs and Exit at the Tips of Hairs Where Walls are Thin. Microbes Reform Cell Walls Once Outside Root Hair.)

Plant Cell Entry Zone
(Microbes Become Intracellular in Meristem Cells as Wall-less Protoplasts.)





Bacteria (arrow) in root parenchyma cell near root tip meristem.



Bacteria (arrow) emerging from root hair tip of millet seedling.

Nutrients Extracted from Microbes By Reactive Oxygen Produced by NOX on Root Cell Plasma Membranes

Microbes Exit Root Hairs Exhausted of Nutrients

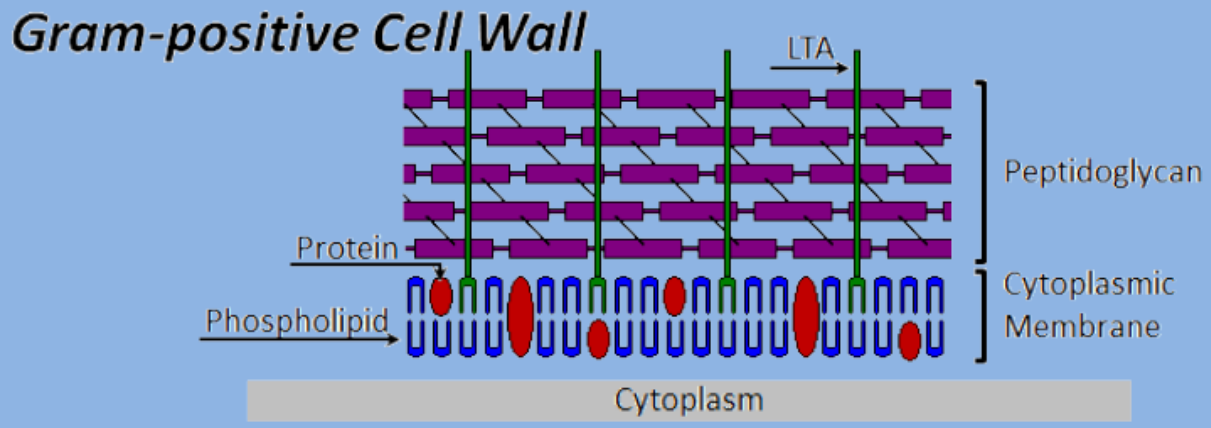
RHIZOPHAGY CYCLE

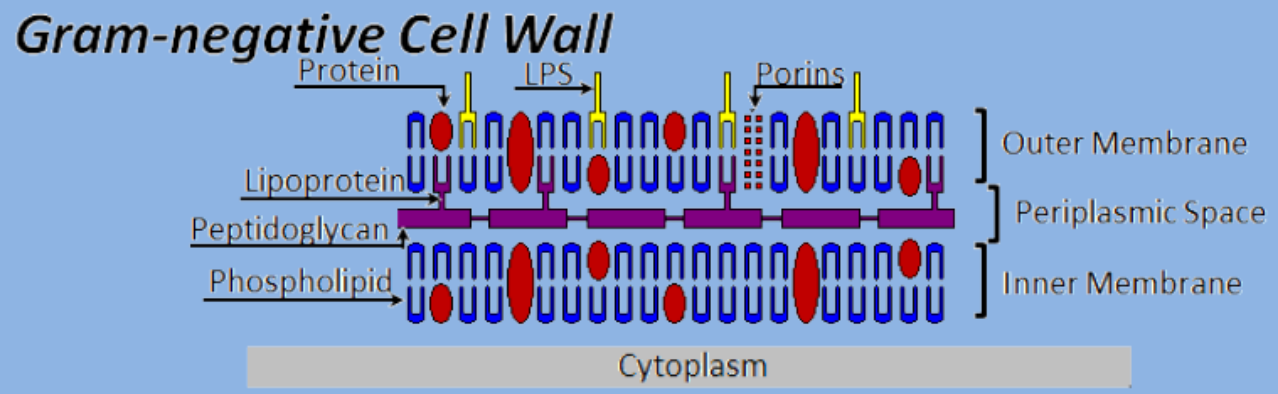
Microbes Enter Root Cell Periplasmic Spaces Carrying Nutrients From Soil

Microbes Recharge with Nutrients in the Rhizosphere

What is contained in bacterial cell walls?

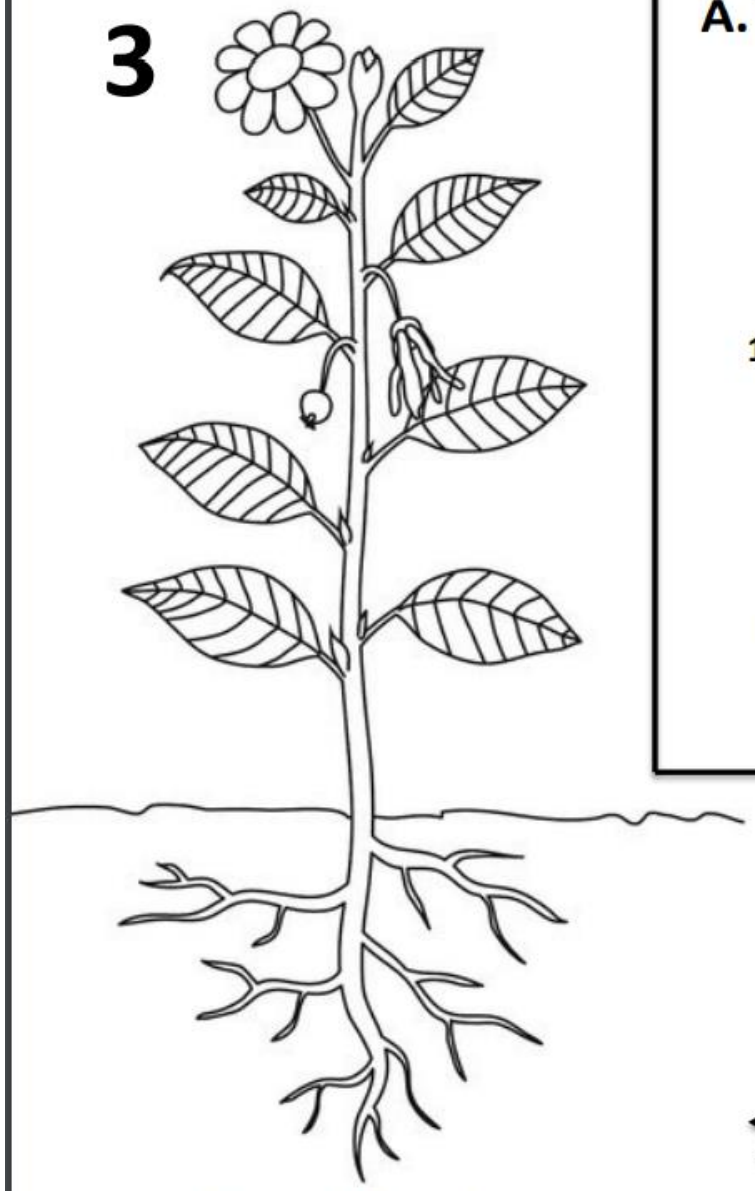
Nitrogen!!!





- Gram - bacteria = amino acids = alanine, glutamic acid, diaminopimelic acid
- Gram + bacteria = amino acids = alanine, glutamine, lysine, glycine

3



The plant takes nutrients from rhizophagy cycle microbes, and provides photosynthate to soil microbes.

A. Three Beneficial Outcomes of Rhizophagy Symbiosis

1. Plants absorb nutrients from microbes

Rhizophagy microbes enter plant roots with nutrients

2. Increased oxidative stress tolerance in plants

Increased reactive oxygen activity in root cells

3. Soil fungal pathogens have reduced virulence

Soil fungi drained of nutrients by rhizophagy cycle microbes

B. Nutrient Flow

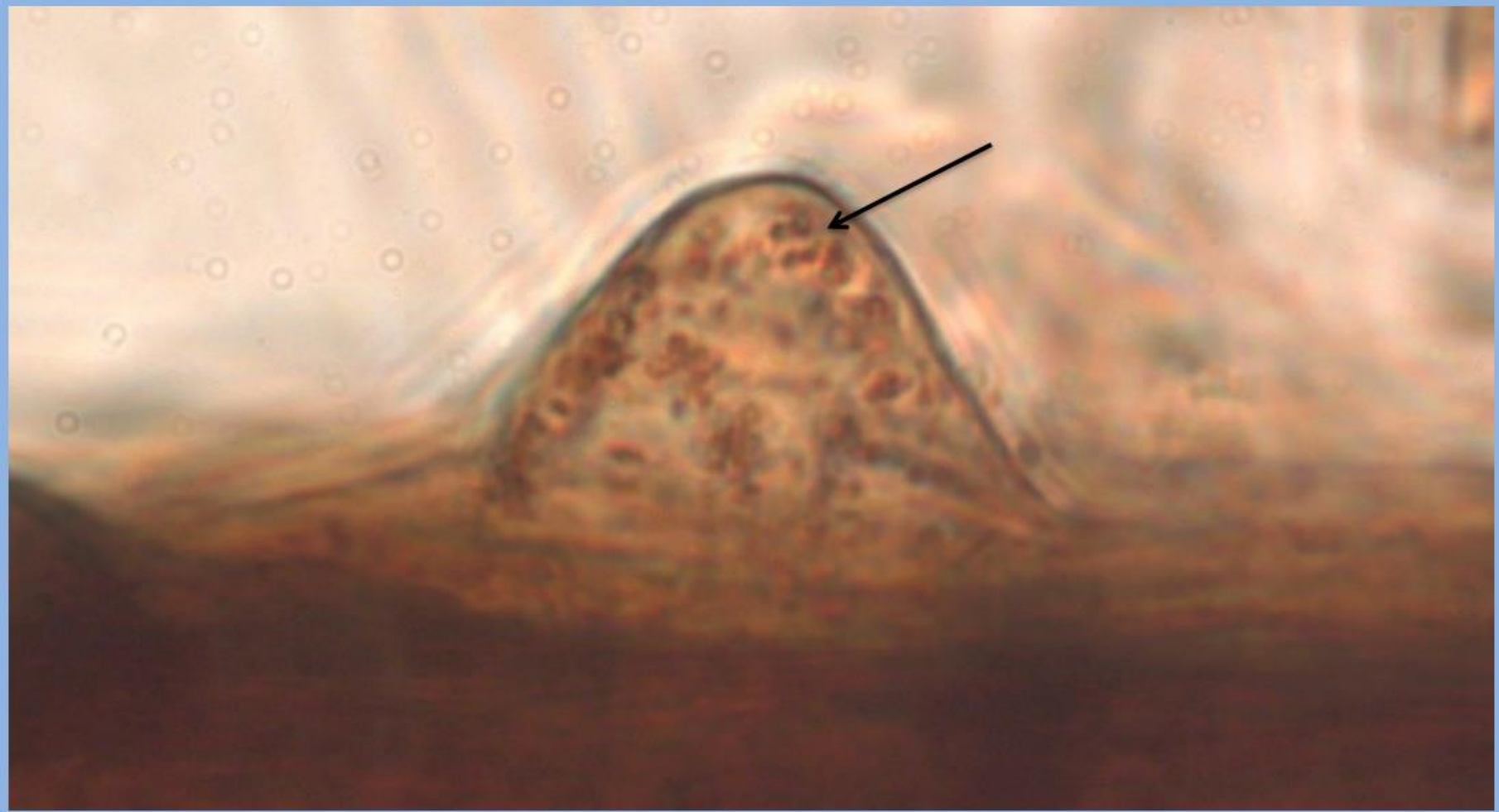
Rhizophagy cycle microbes take nutrients from microbial community.

The soil microbial community liberates and absorbs nutrients from soil.

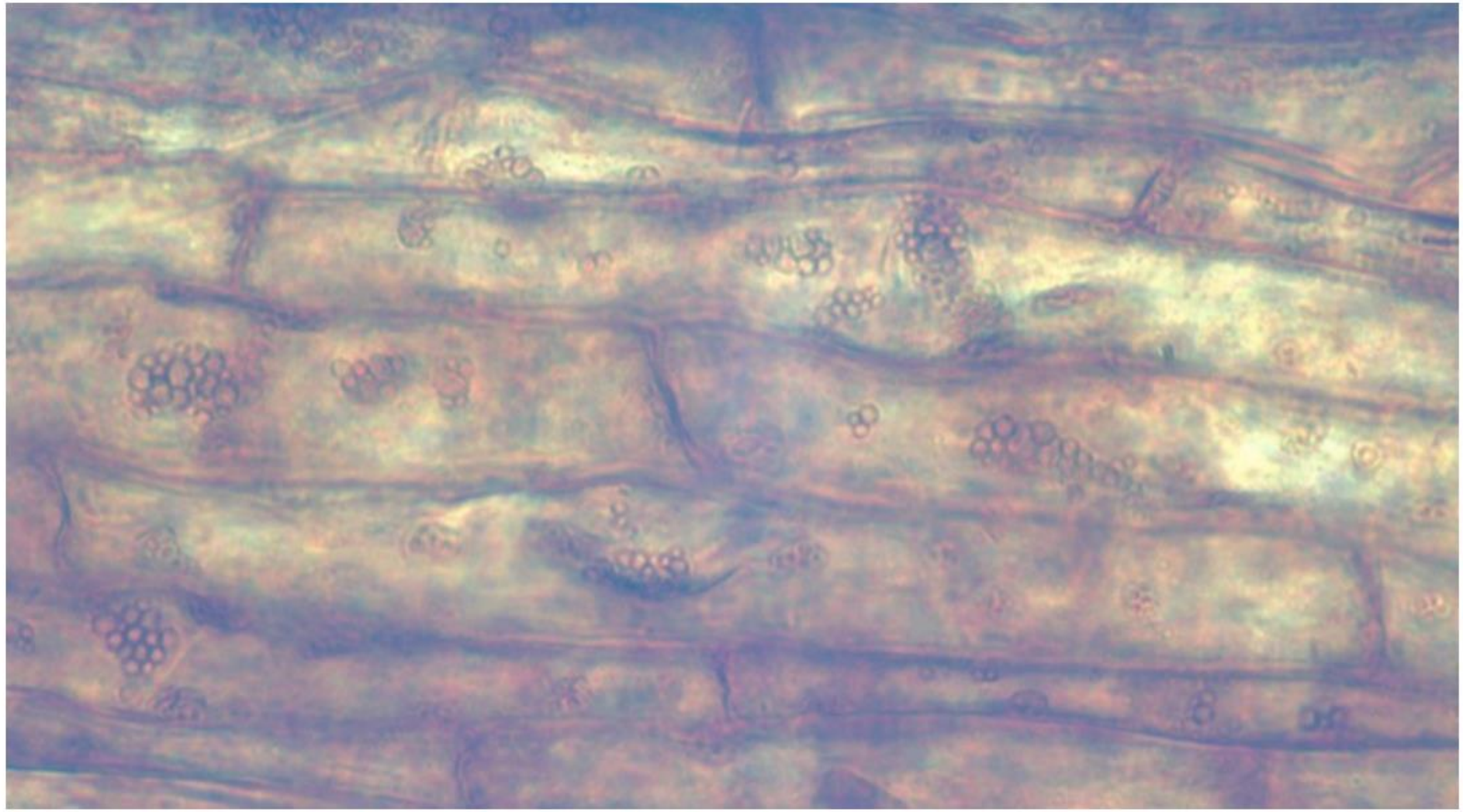
Rhizophagy cycle microbes modulate development of seedlings

- Microbes trigger the gravitropic response in roots
- Microbes trigger root hair elongation
- Microbes increase root branching
- Microbes increase root and shoot elongation

Tomato seedling hair initial with internal replicating bacteria (arrow).



Bacteria in carrot root epidermis cells



The Growers Purpose

- Nourishment
- Knowledge, Understanding and Wisdom
- Livelihood
- Ministry/Evangelism


“Taste and see that the Lord is good . . .”
– Psalms 34:8


Questions?