



THE BACKYARD GARDEN BLUEPRINT

Session 2: Soil Health

OVERVIEW:

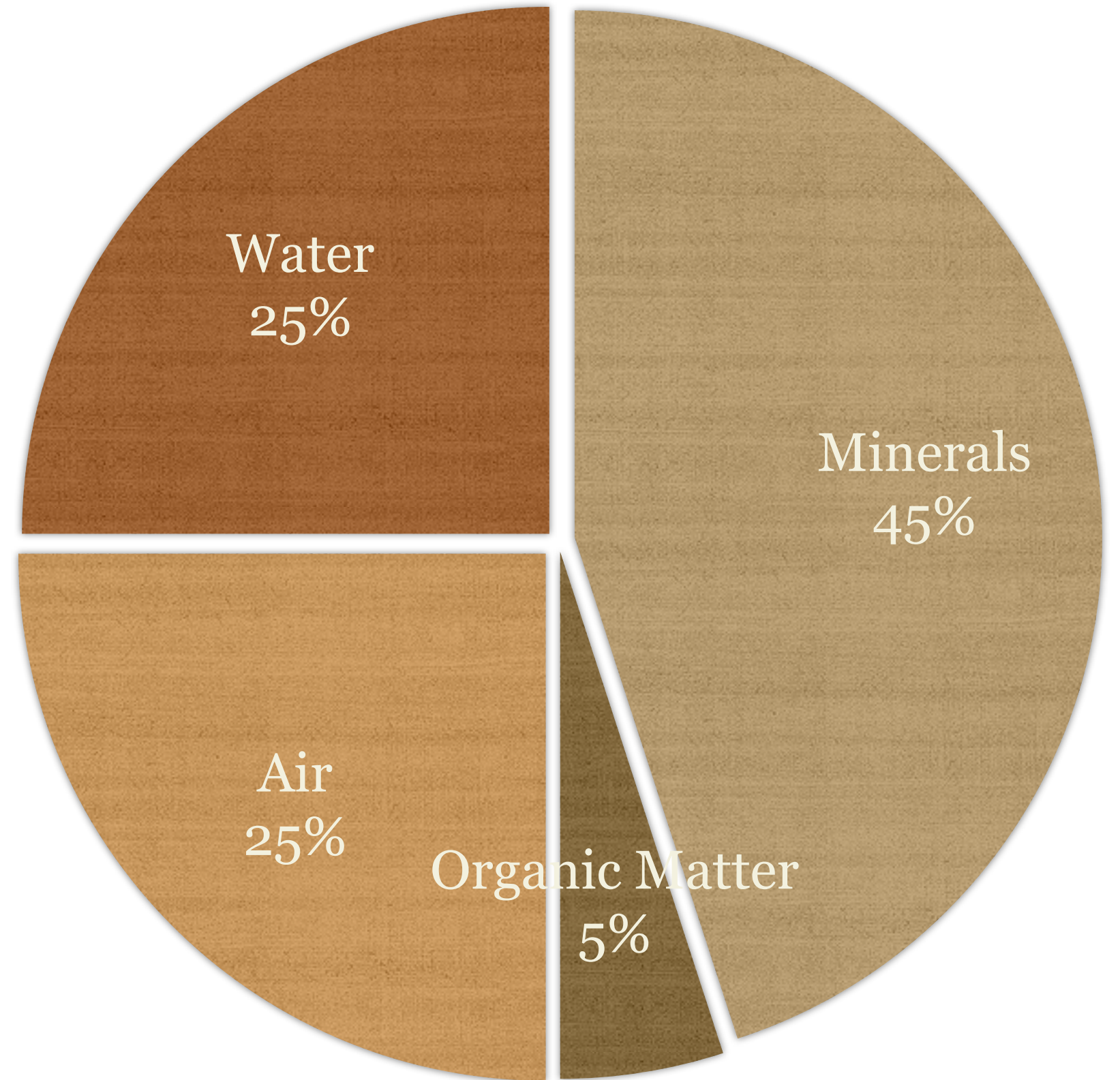
1. The Basics
2. Soil and plant nutrition basics
3. Six soil health principles (Part 1)



THE BASICS

SOIL COMPOSITION CHART

1. Each component plays a significant role.
2. Soil health and fertility is a function of all these components in relationship and much more.



THE BASICS

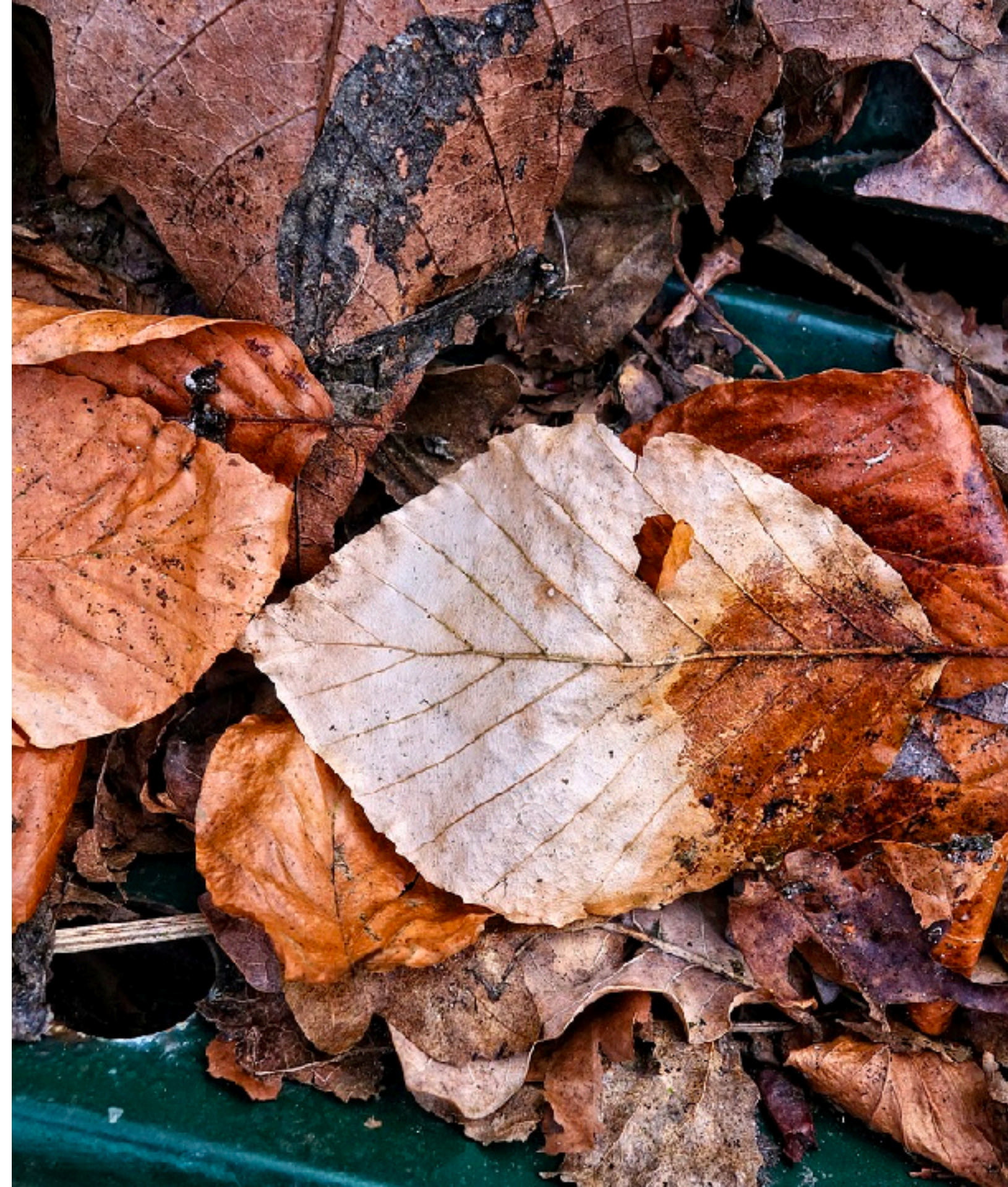
1. Minerals - traditional soil science has focused here
 1. Clay
 2. Silt
 3. Sand
 4. Mineral soil nutrients



THE BASICS

1. Organic Matter

1. Dead plant debris (leaves, sticks, roots, etc.)
2. Dead soil creatures (including microbes)
3. Living plant material - mostly roots
4. Living creatures, protozoa, bacteria and fungi



THE BASICS

1. Pore Spaces

1. Essential for air and water movement in soil
2. Why are air and water necessary?
3. What creates pore space?
 1. Sand and gravel in the soil
 2. The activity of soil creatures (worms, ants, others)
 3. Aggregates



THE BASICS

1. Aggregates

1. Aggregates are minerals and organic matter bound together in clumps that vary in size and shape.
2. Soil aggregates are a key, visible indicator of soil health
3. More on aggregates later!





SOIL AND PLANT NUTRITION BASICS

SOIL & PLANT NUTRITION

1. It is really not possible to talk about soil health without talking about plants and soil biology - everything is connected!



SOIL & PLANT NUTRITION

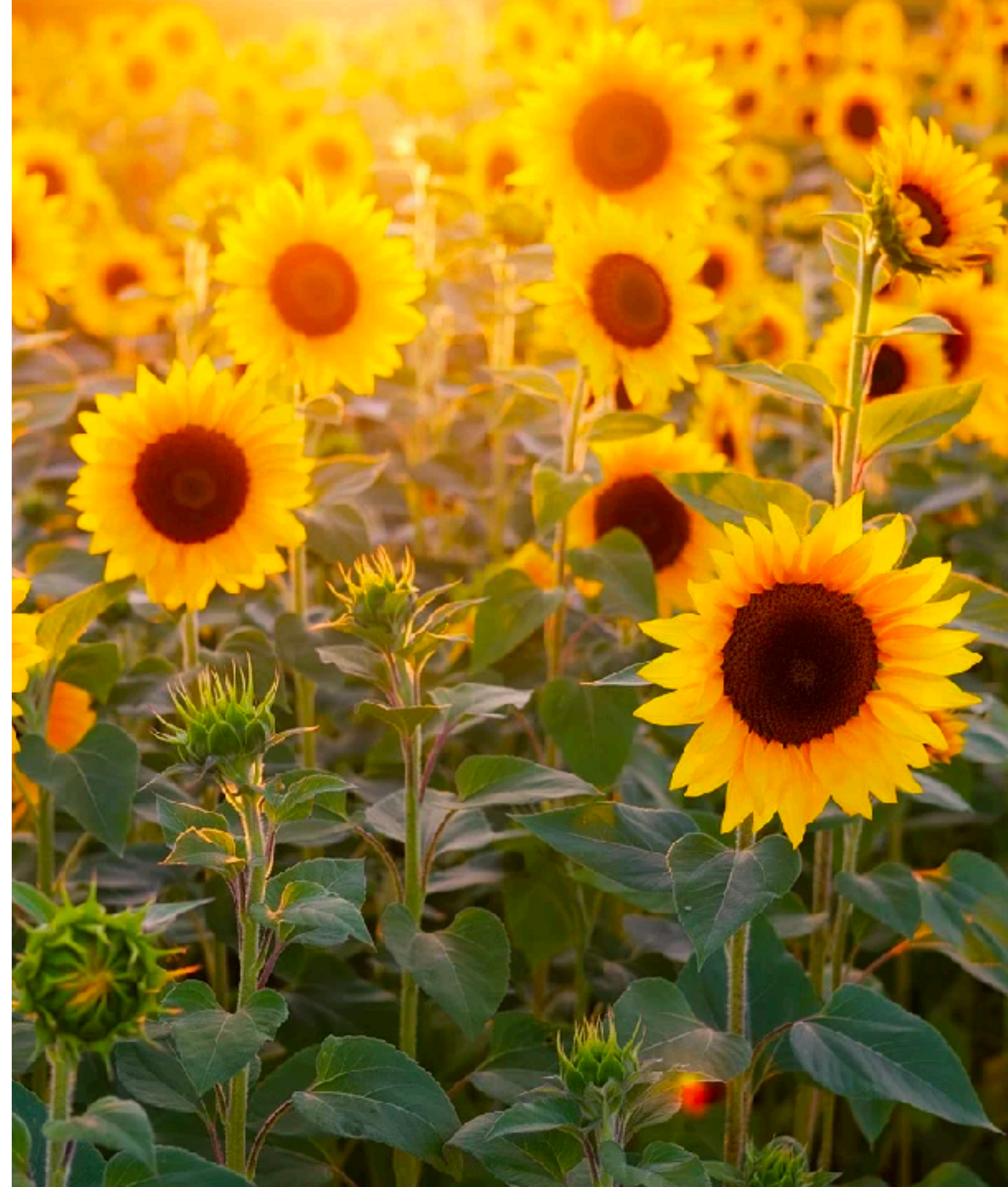
1. The Sun! It all starts far from the soil and from this earth.
 1. Light from the sun is what drives plant nutrition, soil health and life on earth!
 2. In Photosynthesis, the plant uses energy from the sun along with CO_2 and H_2O , to produce sugars (liquid carbon).



SOIL & PLANT NUTRITION

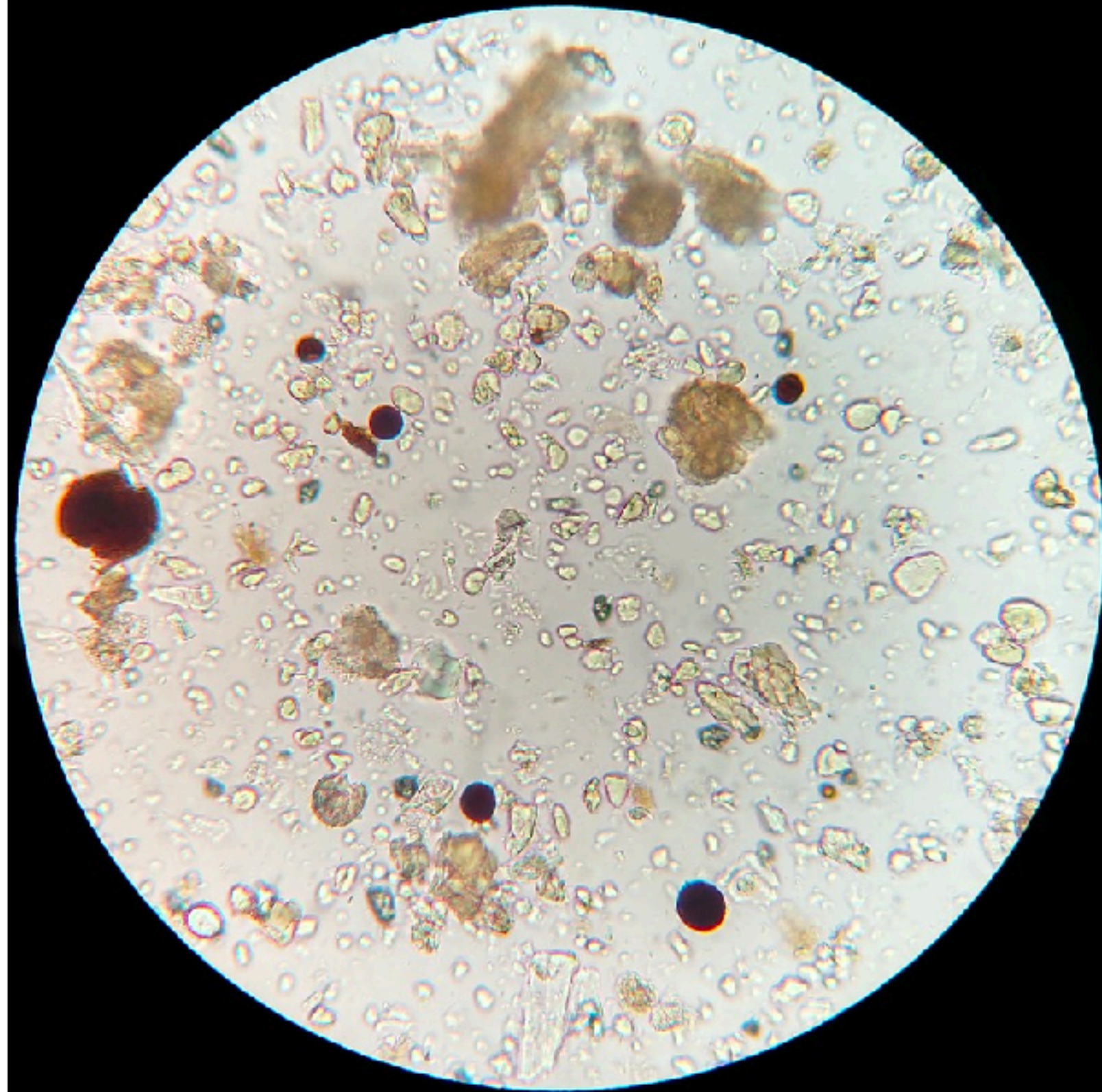
1. Liquid Carbon Pathway

1. Plants take in CO_2 and H_2O
2. Photosynthesis occurs, using energy from the sun
3. Oxygen and carbohydrates (liquid carbon) are produced
4. A portion of this “liquid carbon” is moved to the roots
5. And exuded from the roots into the soil



SOIL & PLANT NUTRITION

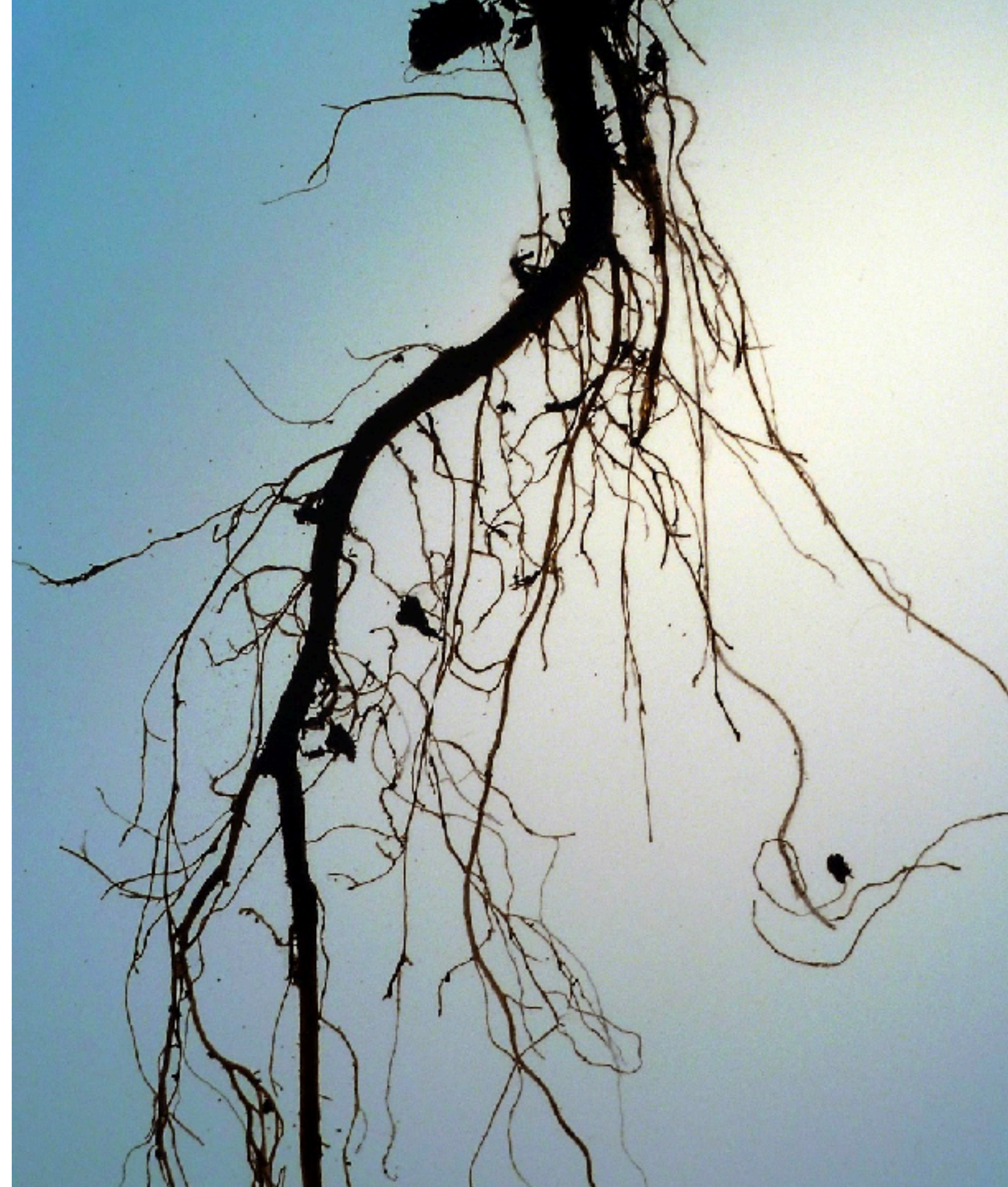
1. A large portion of exudate is consumed by microbes
2. And part of it combines with water to form carbonic acid
 1. This mild acid breaks down rocks and organic matter
 2. Making nutrients available for consumption by soil microbes



SOIL & PLANT NUTRITION

1. The Rhizosphere - a thin, exudate rich, film that surrounds roots and has a heavy microbial population. We will highlight three types of microbes that operate in the rhizosphere:

1. Mycorrhizal Fungi
2. Diazotrophs
3. Heterotrophs



SOIL & PLANT NUTRITION

1. **Mycorrhizal Fungi** form symbiotic relationships with plant roots
 1. Extend the reach of roots through mycelial hyphae - expanding the rhizosphere into the mycorrhizosphere.
 2. This increased surface area comes into contact with up to 100 times more soil.



SOIL & PLANT NUTRITION

1. Healthy populations of Mycorrhizal fungi have been shown to:
 1. Increase availability of nutrients to plants
 2. Improve drought tolerance
 3. Increase pest and disease resistance
 4. Speed up development of plants/fruits
 5. Increase quantity of flowers/fruits



SOIL & PLANT NUTRITION

1. **Diazotrophs** - microorganisms, mostly bacteria, that fix nitrogen from the air and convert it into forms usable by soil organisms and plant roots. There are two primary categories of diazotrophs:
 1. Symbiotic diazotrophs
 2. Free-living diazotrophs



SOIL & PLANT NUTRITION

1. Diazotrophs slow N fixation or shut it down altogether when:
 1. Synthetic Nitrogen is added to the soil
 2. Soil contains excess levels of O, as is the case after tillage



SOIL & PLANT NUTRITION

1. **Heterotrophs** - organisms that cannot produce their own energy. This category includes many bacteria and fungi, as well as nematodes, insects, mollusks, earthworms and animals.



SOIL & PLANT NUTRITION

1. All heterotrophs require the fuel that is originally supplied by photosynthesis.
2. The soil heterotrophs thrive best in undisturbed soil that is covered in plant material.
3. Among heterotrophs, there are decomposers, predators and prey, aerators and mixers, all comprising the diversity that keeps nature balanced.



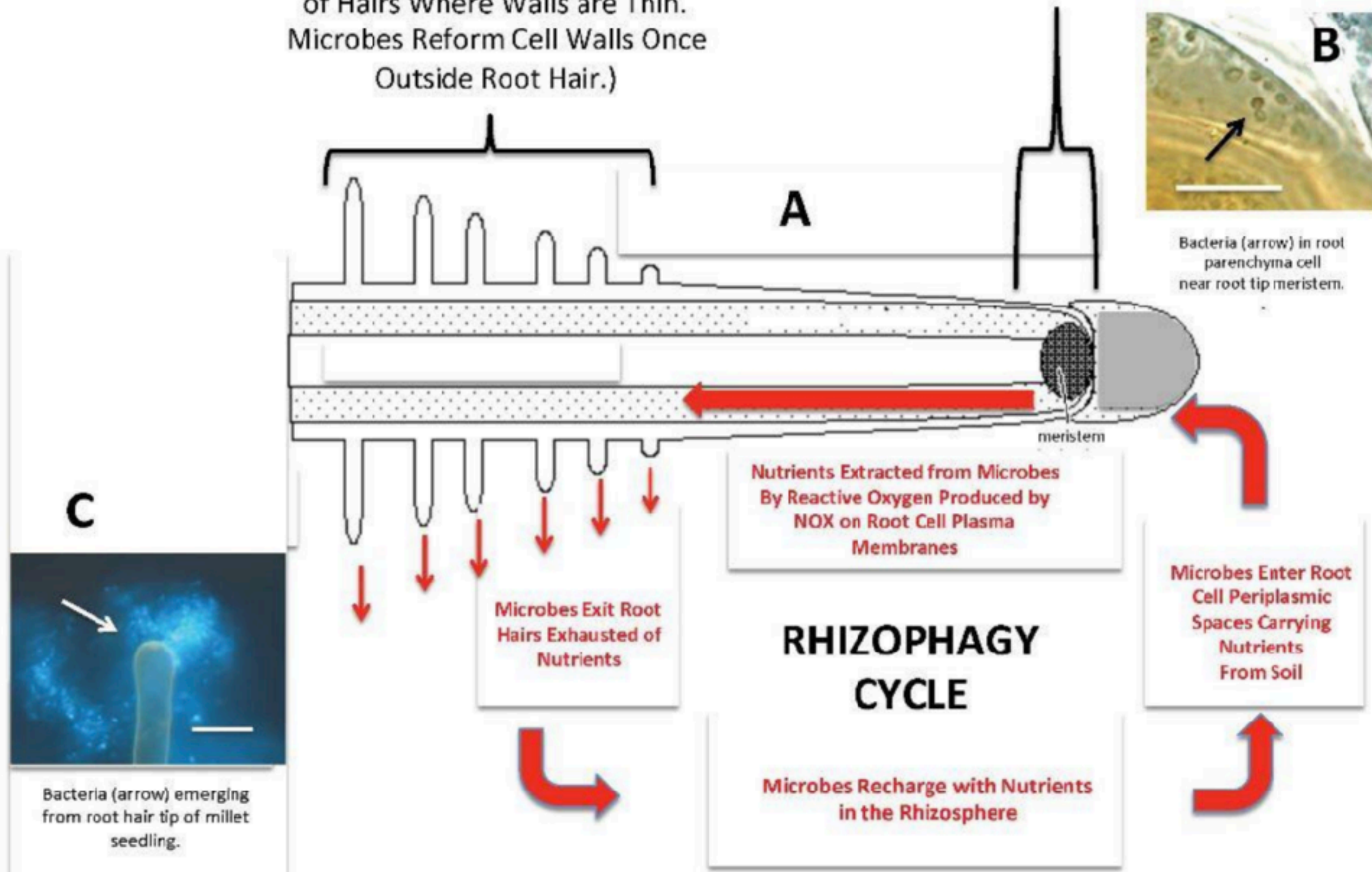
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Microbe Exit Zone

(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.)





SIX SOIL HEALTH PRINCIPLES

A close-up photograph of a person's hand holding a small, young green plant seedling over a patch of dark, rich soil. The soil is covered with small twigs and organic matter. The hand is positioned in the upper right quadrant, with fingers gently supporting the seedling. The seedling has a few green leaves and a small, reddish-brown bud at the top. The background is slightly blurred, focusing attention on the hand and the plant.

1: MINIMAL DISTURBANCE

1: MINIMAL DISTURBANCE

1. Both mechanical and chemical
2. What tillage can do to soil structure
 1. Tillage destroys soil structure
 2. Tillage reduces water infiltration
 3. Tillage reduces organic matter
 4. Tillage increases weeds



1: MINIMAL DISTURBANCE

1. Tillage destroys soil structure by:
 1. Breaking up soil aggregates
2. Aggregates provide “structure” to soil, which:
 1. Increase porosity of soil for better air and water movement in soil
 2. Increases water infiltration and retention
 3. Reduce runoff and erosion



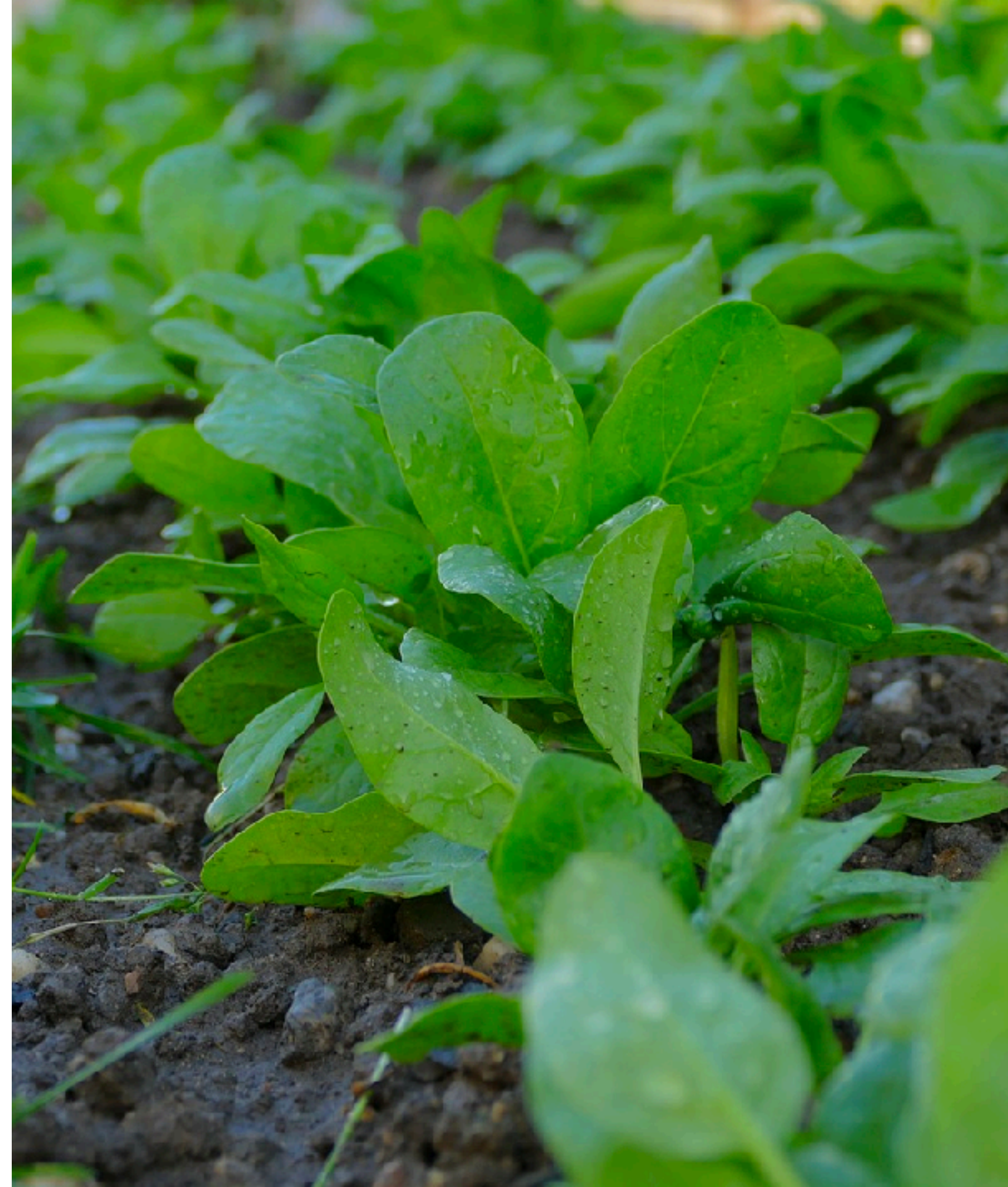
1: MINIMAL DISTURBANCE

1. Aggregates are formed by the life in the soil.
 1. Plant roots - exudates
 2. Around organic matter (by bacterial and fungal decomposers) - polysaccharide “glues”
 3. The activity of earthworms
 4. Mycorrhizal fungi play a star role in the development of soil aggregates.
 1. Fungal hyphae
 2. Glomalin produced by fungal hyphae



1: MINIMAL DISTURBANCE

1. Ways to increase Mycorrhizal fungi
 1. Reduce/eliminate chemical usage
 2. Reduce/eliminate tillage
 3. Reduce/eliminate synthetic fertilizers
 4. Keep living roots in the soil as much as possible



SOIL HEALTH RESOURCES

Some of the slides in this presentation were not available for public distribution and have been removed. For more information on soil health we highly recommend the following resources:

<https://understandingag.com>

<https://soilhealthacademy.org>

CLASS HANDOUTS

borntogrow.net/adagra