



Soil Biology

Objectives

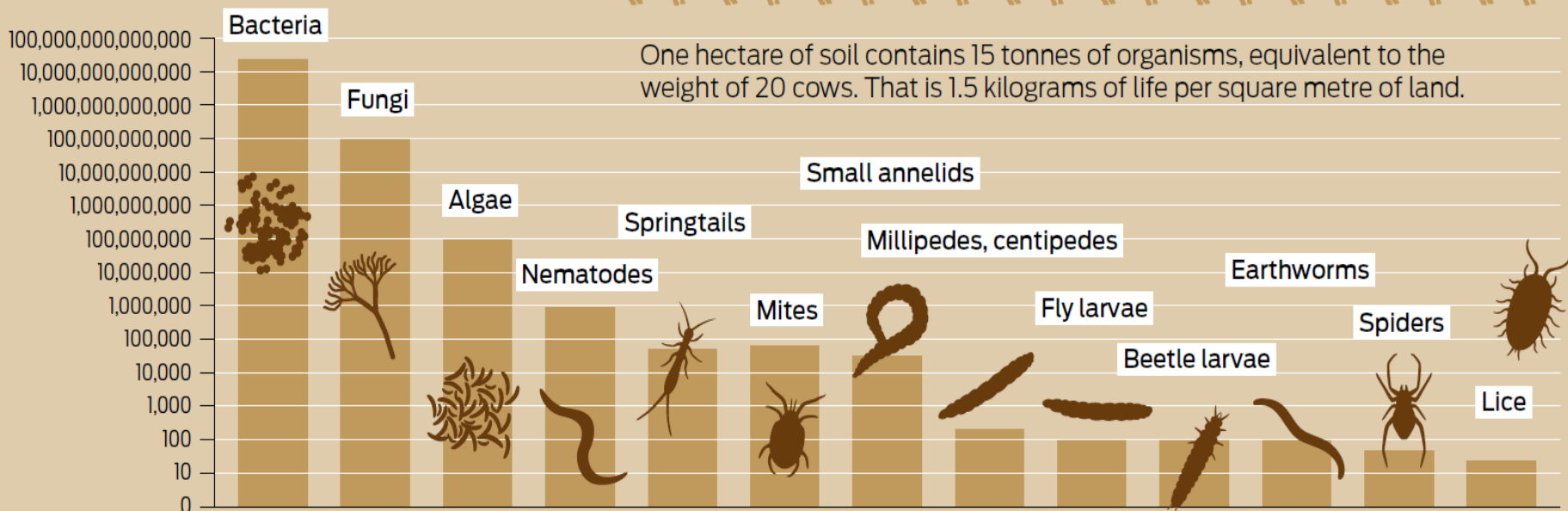
1. List one key activity performed by each of the three functional groups for soil organisms
2. List two soil organisms that represent each functional group
3. Describe biological hotspots & how they relate to key ecosystem functions



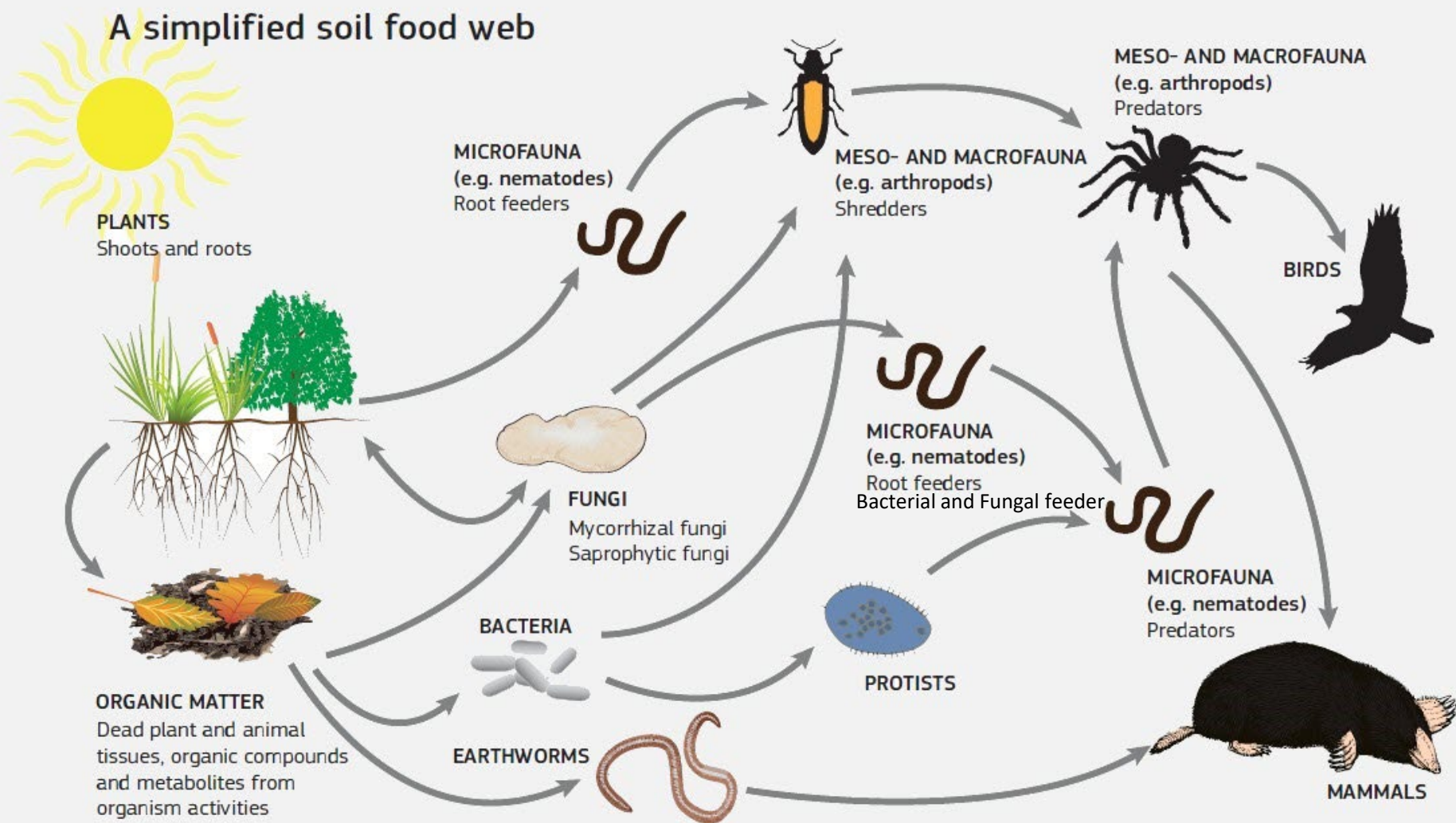
Soils Host Vast Numbers, Mass, and Diversity of Organisms

TEEMING SOILS 1.3 yd³

Number of living organisms in 1 cubic metre of topsoil in temperate climates, logarithmic scale



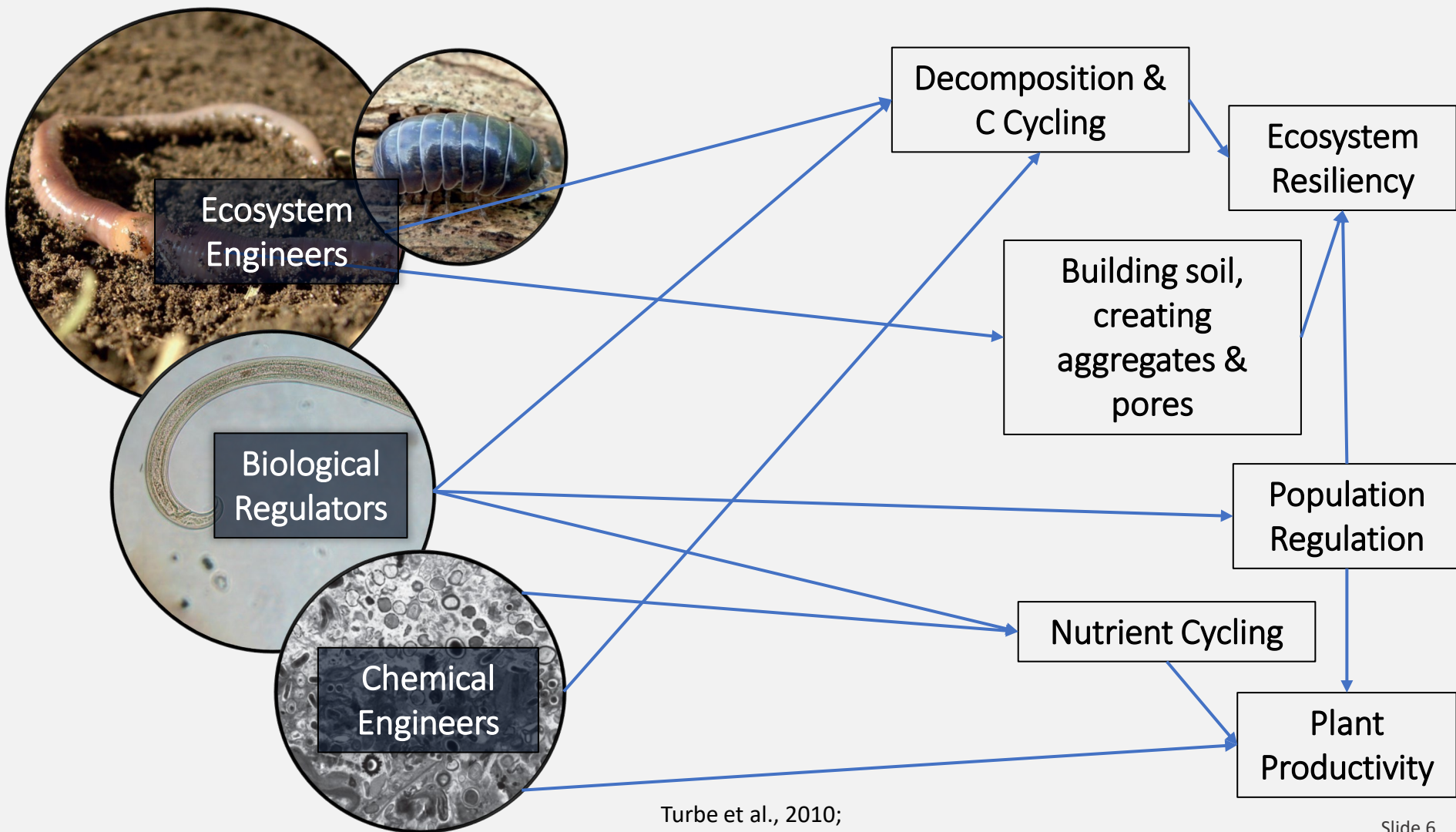
Source: <http://globalsoilweek.org/soilatlas-2015>



Soil Organisms

3 Functional Groups

Key Ecosystem Functions



Ecosystem Engineers

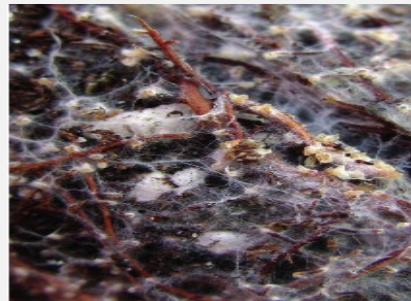
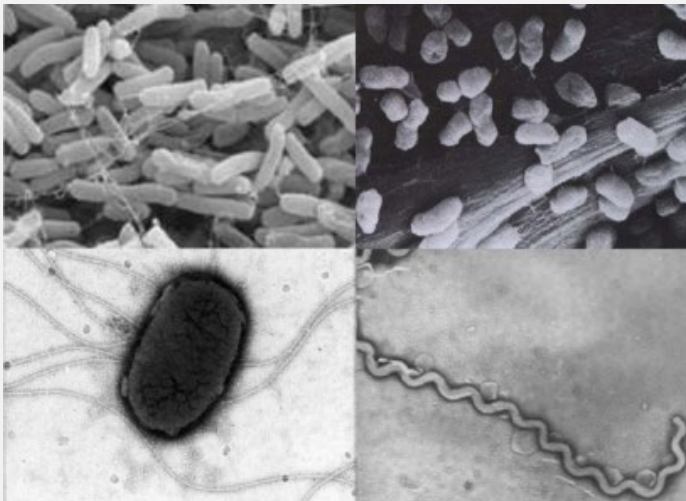
Functional group	Function	Representative members
Ecosystem Engineers	Build pore networks, aggregates, soil mixing	Plant roots, earthworms, larger invertebrates (e.g., millipedes, centipedes, beetles)



Modified from Turbe et al., 2010; Images from: Orgiazzi, Bardgett, Barrios et al. 2016. Global Soil Biodiversity Atlas.

Chemical Engineers

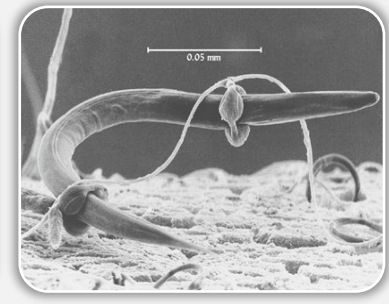
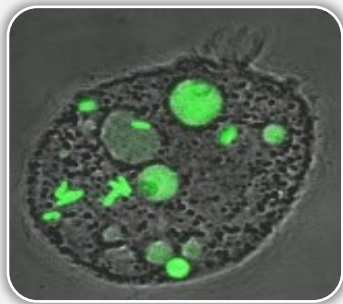
Functional group	Function	Representative members
Chemical Engineers	Regulate 90% of energy flow in soil; Build soil organic matter & aggregates	Soil microbes (bacteria i.e. rhizobia, fungi, protozoa, roots)



Modified from Turbe et al., 2010; Images from: Orgiazzi, Bardgett, Barrios et al. 2016. Global Soil Biodiversity Atlas.

Biological Regulators

Functional group	Function	Representative members
Biological Regulators	Regulate populations of other soil organisms	Protozoa, nematodes, and other small invertebrates (e.g., springtails, mites but also microbes)

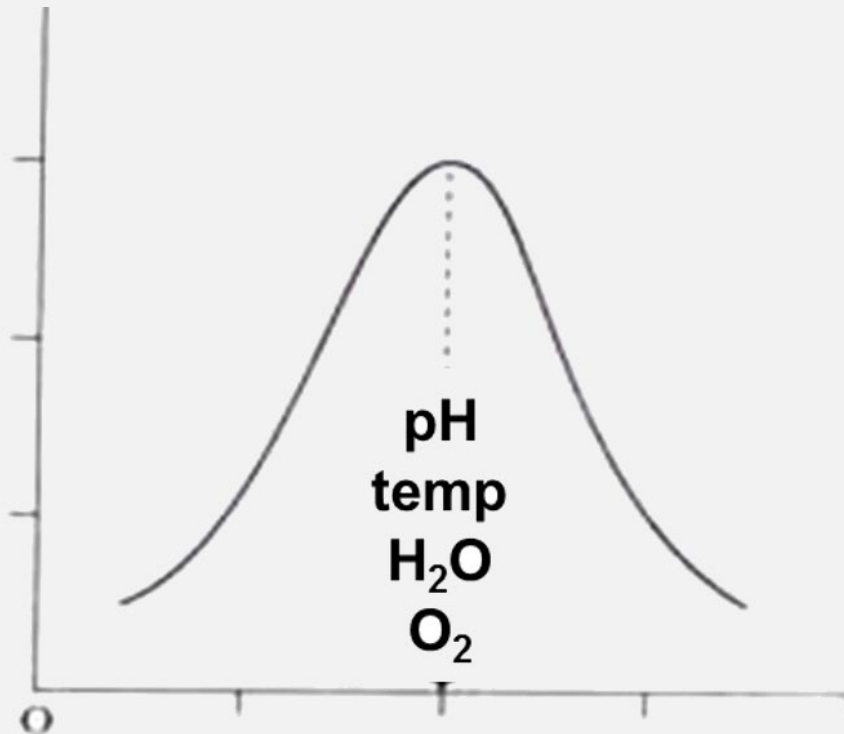


Knowledge check – poll question

Which soil organism functional group is responsible and regulates 90% of the energy flow in soil?

Optimal Activity in Most Ag Systems Occurs When Conditions are 'Just Right'

> 90% bacteria in soil are inactive!



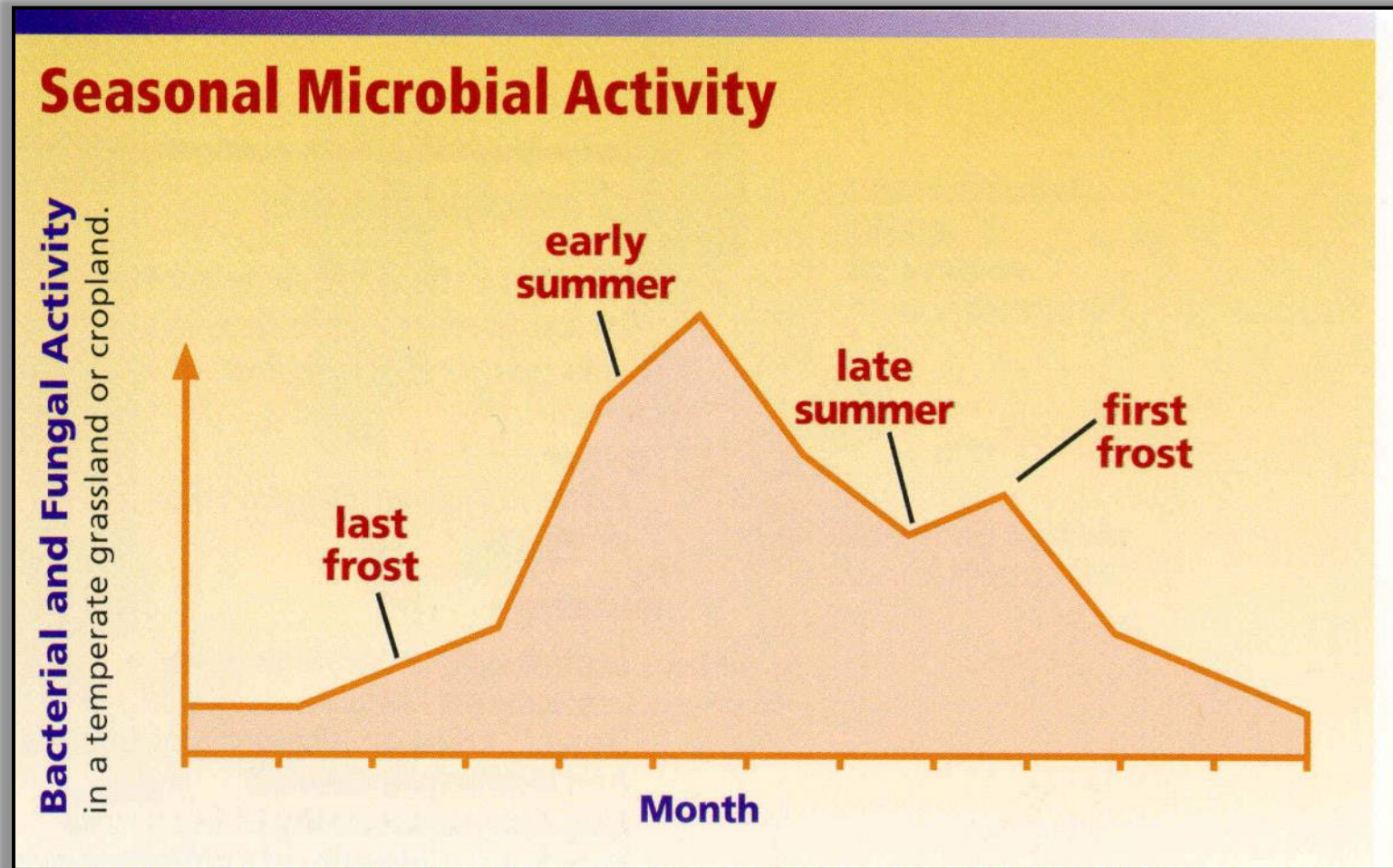
Near neutral pH
Moderate temps
Moist conditions
Aerated
Abundant food (C)



Adapted from Turbe et
al. 2010

Seasonal Microbial Activity

Microbes are impacted by temp and moisture



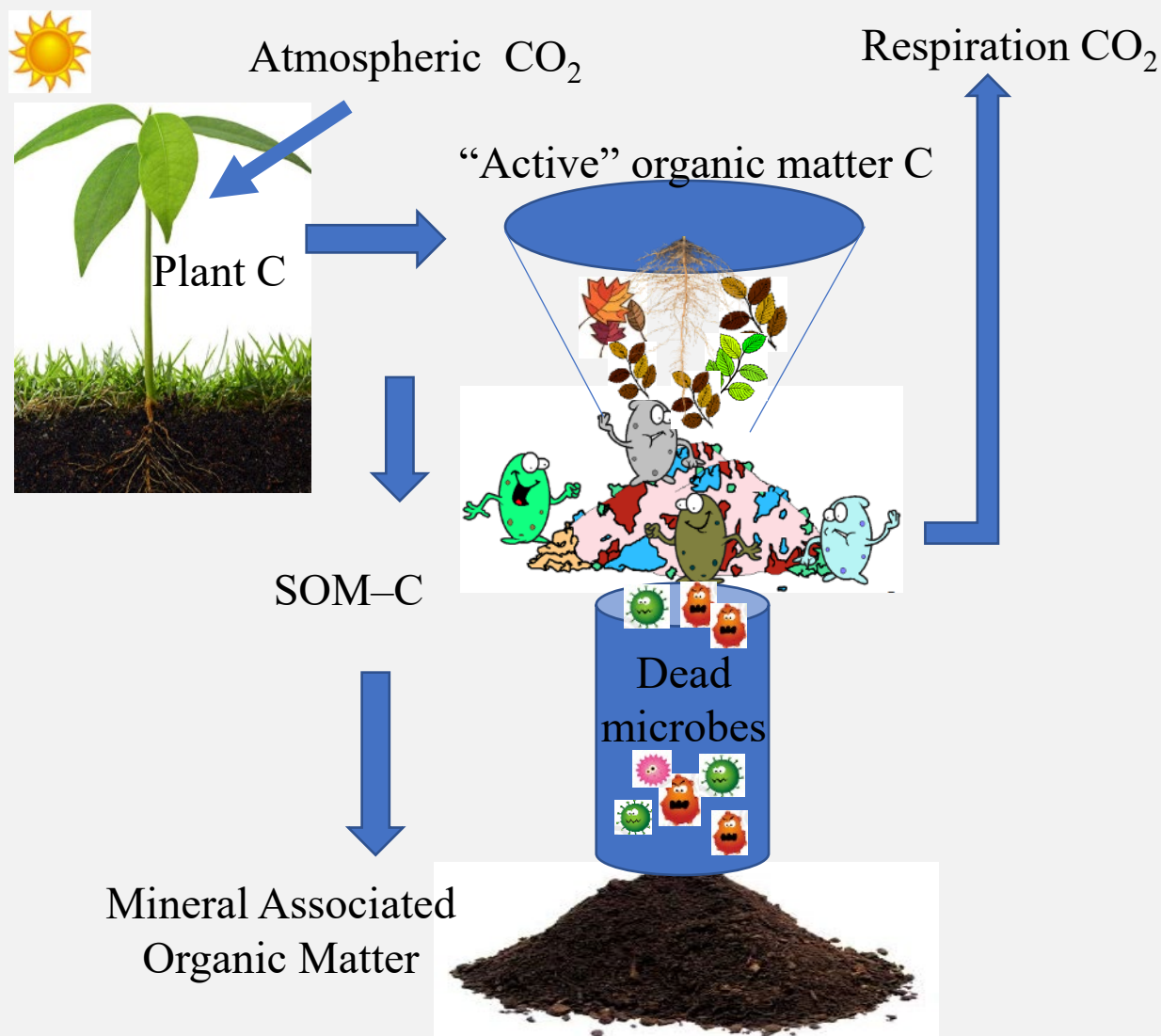
Ingham et al.
2000

Soil Fauna Breakdown Biomass

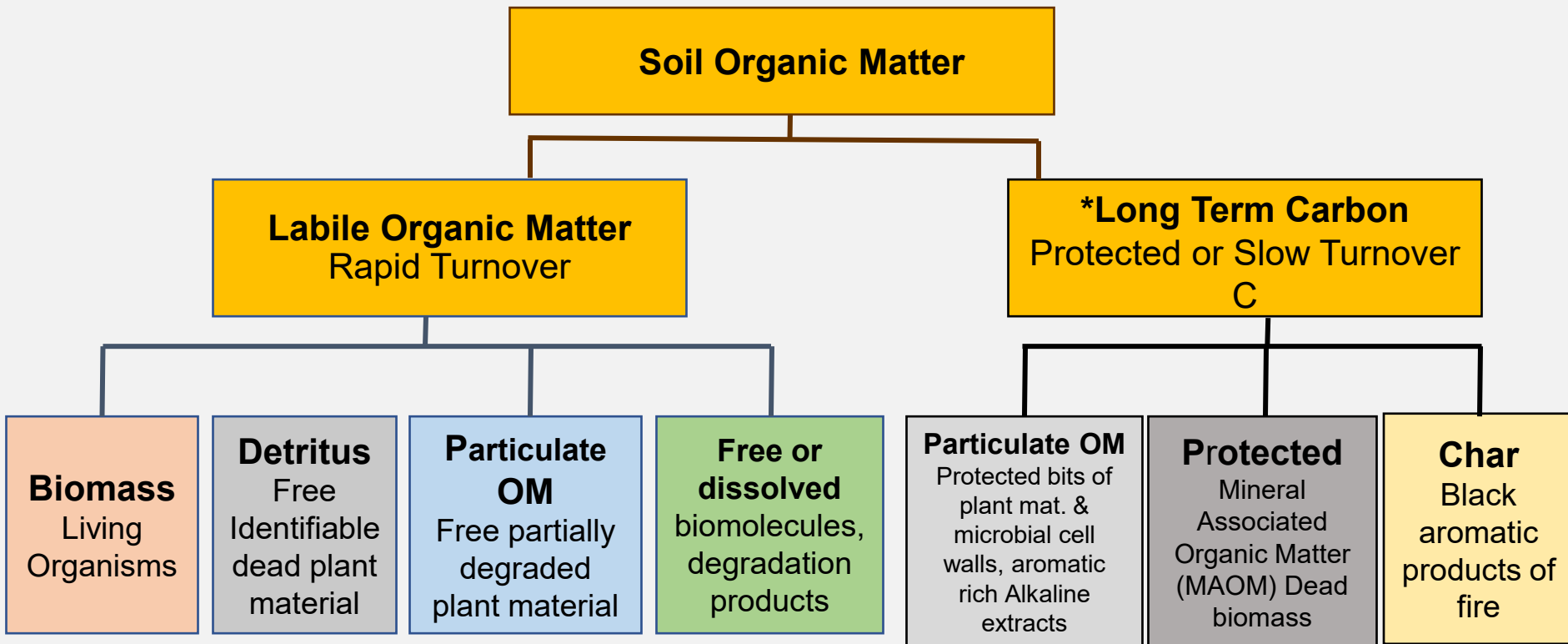
15 week time lapse



Continuous Flow of C Drives System



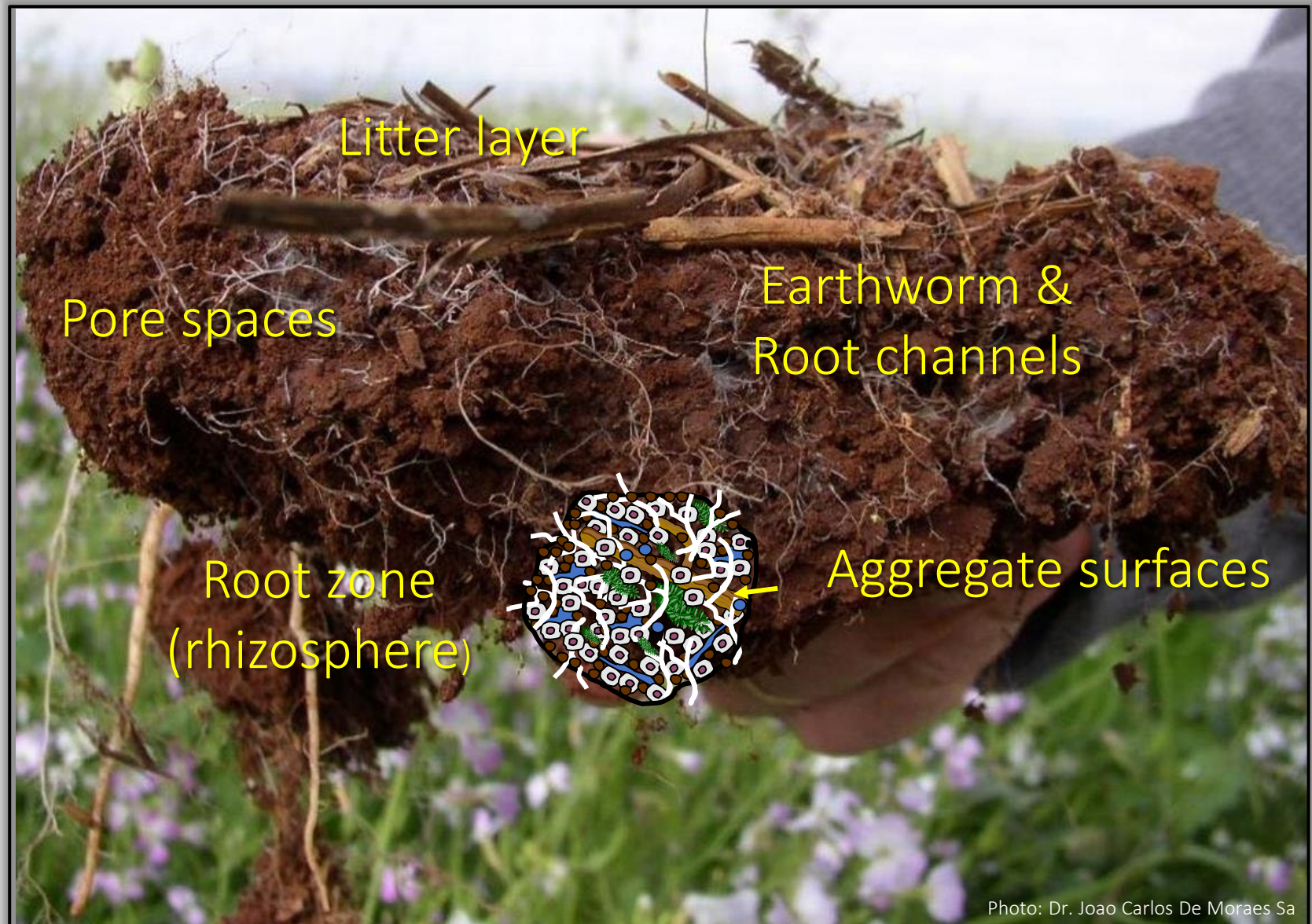
Organic Matter Pools



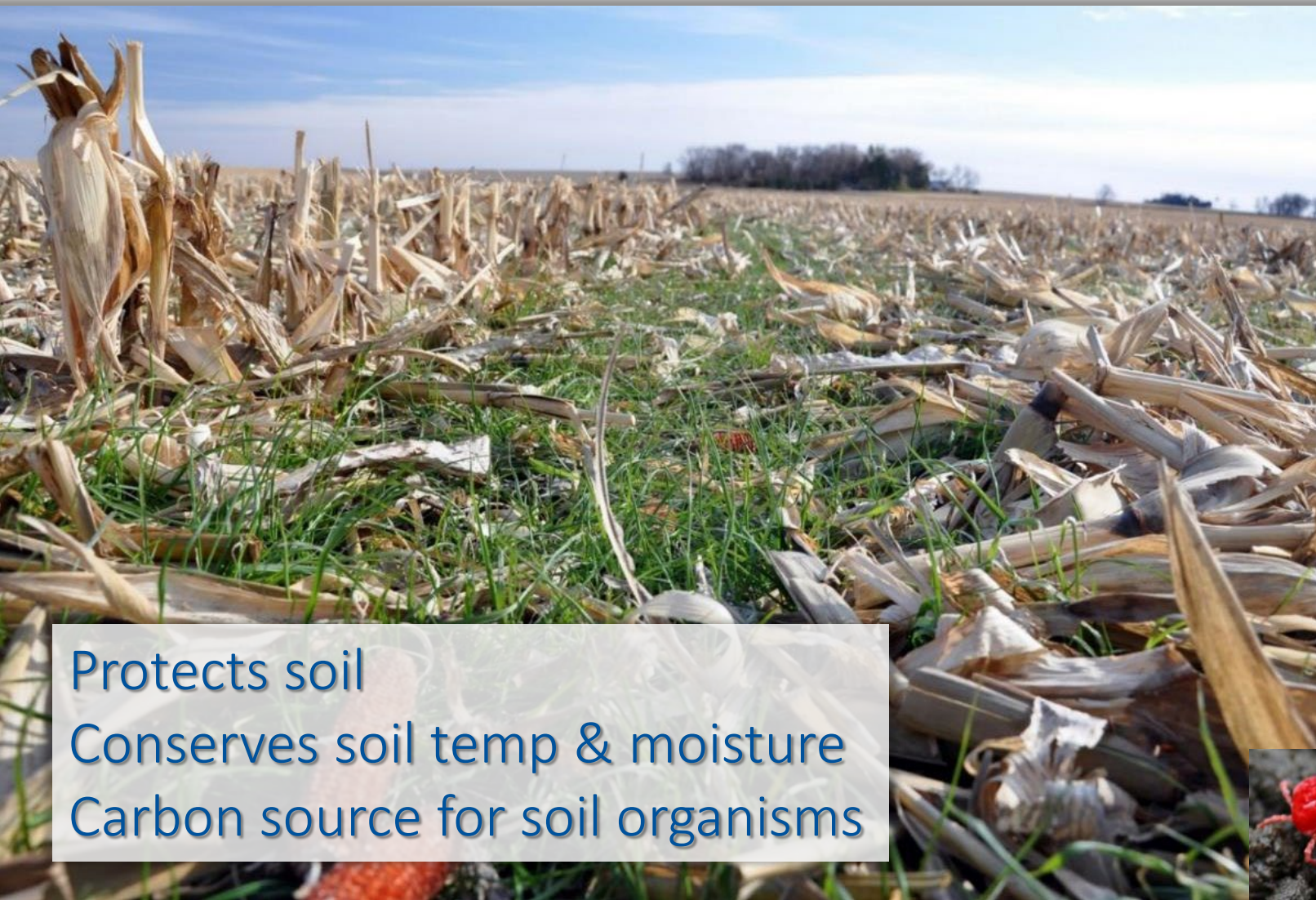
*Protected on clay surfaces, soil aggregates and in ultra-micropores

Adapted from: The Nature and Properties of Soils 15th Edition- Weil and Brady and Sokol et al. 2022 and Camenzind et al. 2023

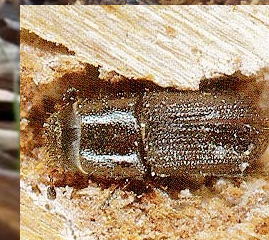
Biological Hot Spots



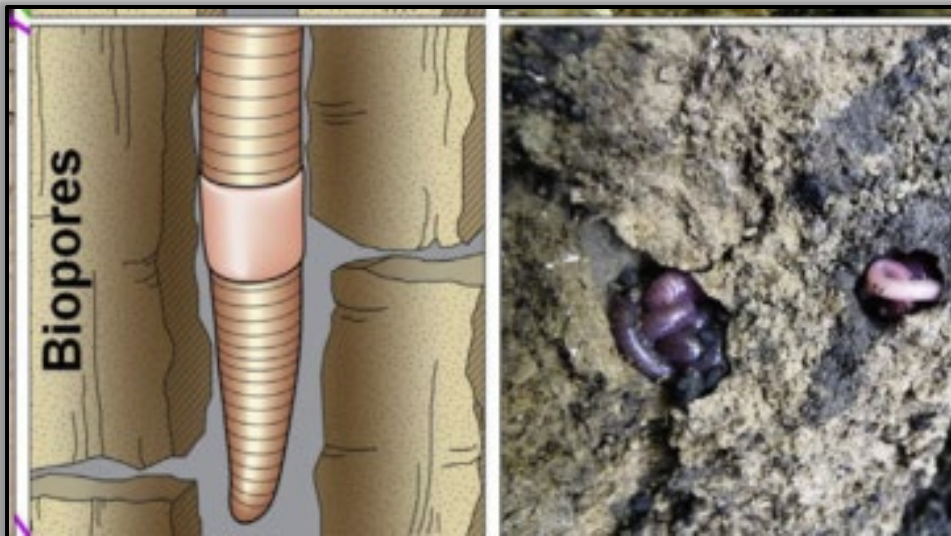
Hot Spot for Ecosystem Engineers: Litter Layer



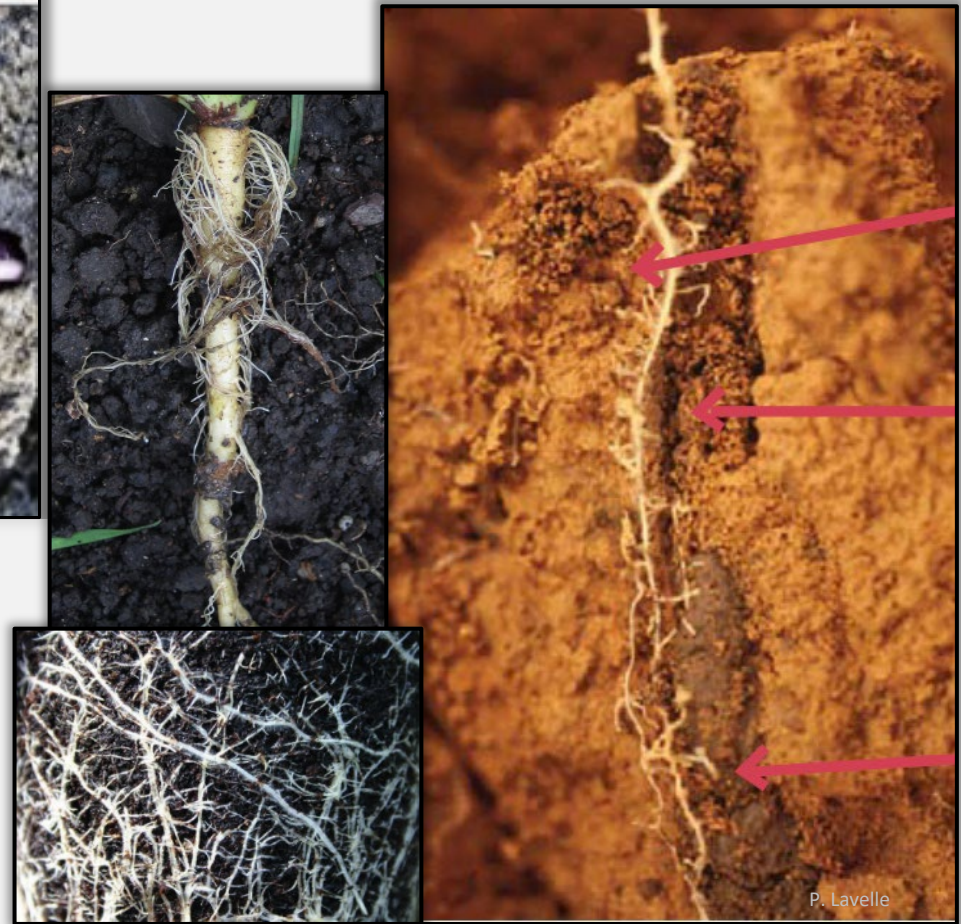
Protects soil
Conserves soil temp & moisture
Carbon source for soil organisms



Hot Spot for Ecosystem Engineers Earthworm and Root Channels



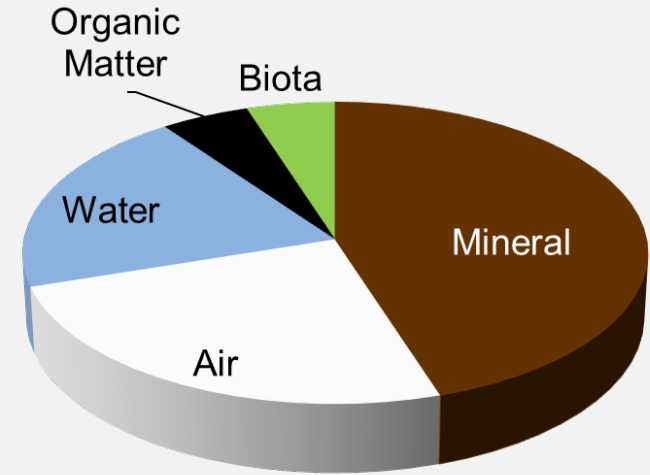
Mixes and moves residues
Large pores
Nutrient rich
Microbially enriched
Air and water flow
Roots grow & take advantage



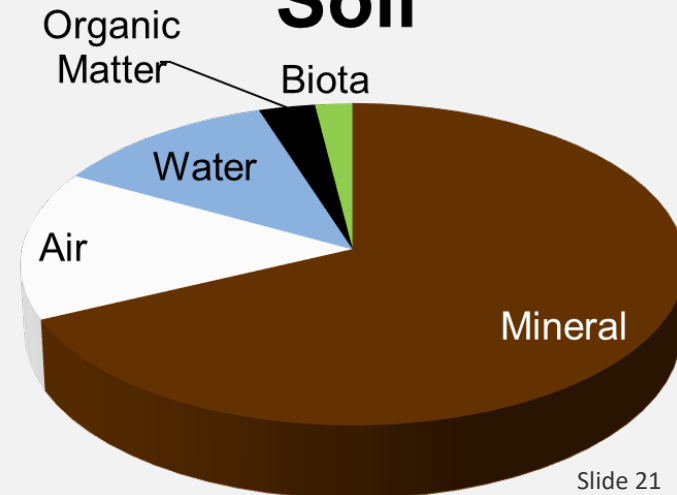
Hot Spots for Chemical Engineers & Regulators in Pore Spaces

- Created via roots, organisms & SH management
- “Lungs & circulatory system”
- Air flow
- Water flow, storage, & availability
- Biological highways

Healthy Soil



Compacted Soil

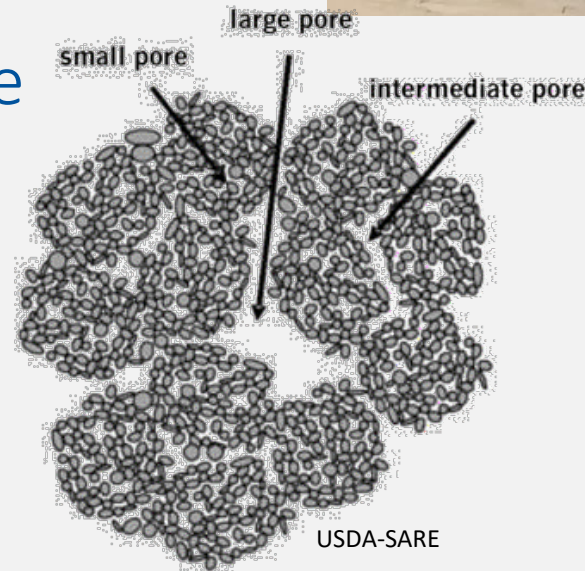


Aggregate Surfaces and Pore Space

- Built with mineral, soil biology and organic materials
- Creates stability and resists erosion
- Protects organic matter and microbes
- Physically supports pore spaces
- Created by microbial glues, fungal hyphae, dead cells, plant roots and Earth worms



J Moore Kucera



Soil Organisms Physically Form & Stabilize Soil Aggregates

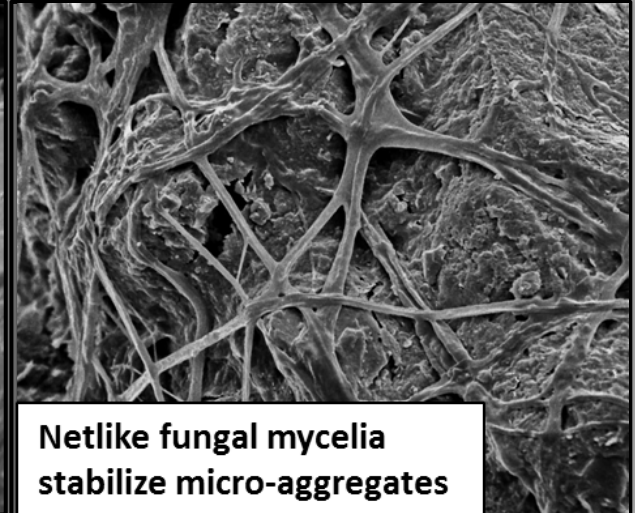
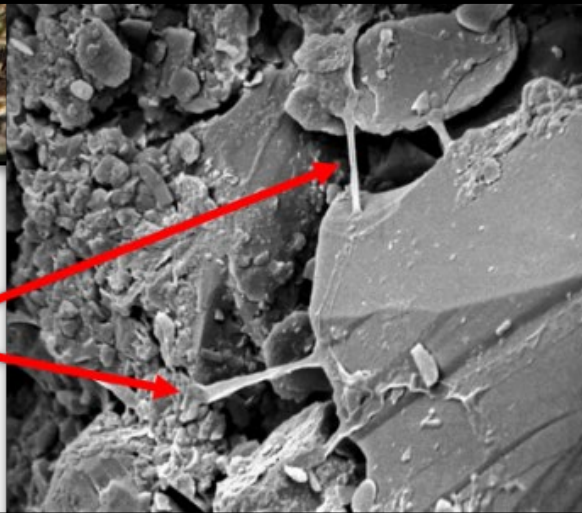


- Plant roots enmesh soil particles
- Earthworm casts
- Fungal and bacterial filaments physically enmesh soil particles



Roth, NRCS

Stabilization of soil structure by actinomycete (bacterial) filaments



Netlike fungal mycelia stabilize micro-aggregates