

Soil Biology - SOIL ORGANISMS

Soil biology is the branch of soil science that deals with organisms and their impacts on soil properties

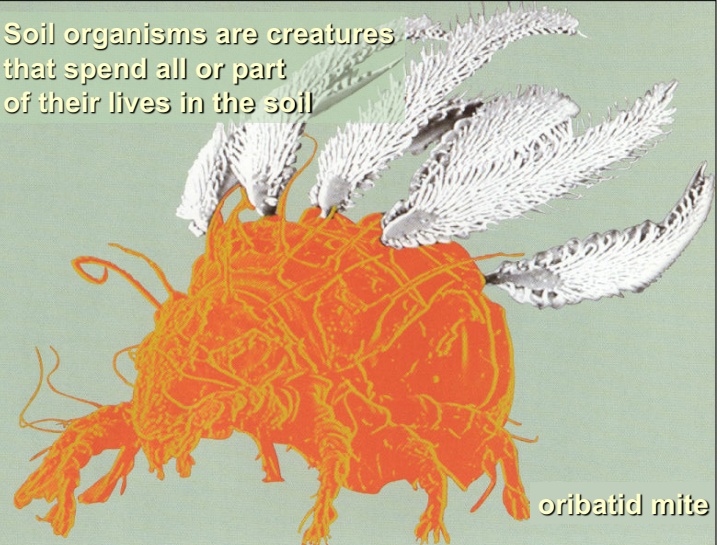
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Lecture outline

- Major groups of soil organisms
- Soil Flora: Plants, Algae, Fungi and Bacteria

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Soil organisms are creatures that spend all or part of their lives in the soil



Major groups of soil organisms

Simplified classification of soil organisms based on:

- **Size of organisms**
 - Macro-* > 2 mm in width
 - Meso-* 0.2-2 mm in width
 - Micro-* < 0.2 mm in width
- **Ecological function** (i.e. what they eat)

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Ecological functions of soil organisms

- **Herbivores** (subsist on living plants)
- **Detritivores** (eat dead plant debris)
- **Fungivores** (eat fungi)
- **Bacterivores** (eat bacteria)

- **Predators** (consume animals)
- **Parasites** (live off other organisms)

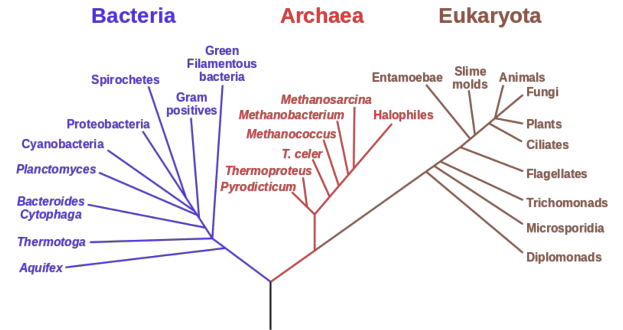
Carbon source:

- **Heterotrophs** (use organic compounds as a source of carbon)
- **Autotrophs** (use CO₂ as carbon source)

Energy source:

- **Phototrophs** (get energy from sunlight i.e. photosynthesis)
- **Chemotrophs** (get energy from chemical oxidation of certain compounds)

Phylogenetic Tree of Life



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Classification of soil flora

Flora

Macroflora: Largely autotrophs

Vascular plants	Feeder roots
Bryophytes	Mosses

Microflora: Largely autotrophs

Vascular plants	Root hairs
Algae	Greens, yellow-greens, diatoms

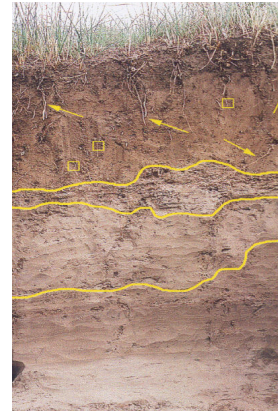
Largely heterotrophs, aerobic

Fungi	Yeasts, mildews, molds, rusts, mushrooms
Actinomycetes [†]	Many kinds of actinomycetes

Autotrophs and heterotrophs

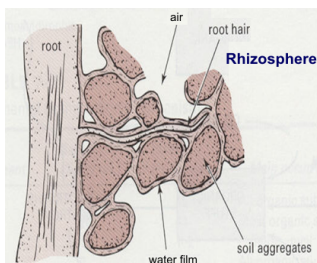
Bacteria [†]	Aerobes, anaerobes
Cyanobacteria [†]	Blue-green algae

Plants provide large quantities of organic residues through roots and litterfall



Plants

Rhizosphere



- **Zone of soil influenced by living roots & associated soil microorganisms**
- **These microorganisms usually feed on the proteins and sugars (called exudates) released by roots and on sloughed-off root cells**
- **Usually extends 1–2 mm out of root surface**

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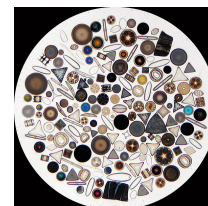
Algae have chlorophyll and perform photosynthesis; live at or close to the soil surface

1) Green algae



European Commission JRC Soil Biodiversity 2011 Calendar

2) Diatoms



3) Yellow-green algae



Robert W. Hoshaw/Encyclopedia Britannica, Inc.

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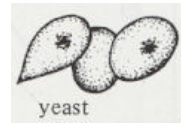
Photos: Maja Krzic (UBC)



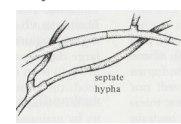
Fungi - heterotrophic (mainly) aerobic organisms, responsible for:

- decomposition of organic matter (convert dead OM to fungal biomass and immobilize nutrients in soil, help accumulation of humic-acid rich organic matter)
- colonization of plant roots (mycorrhizal fungi)
- killing plants (pathogens)
- biocontrol (help control diseases)

1) Yeast



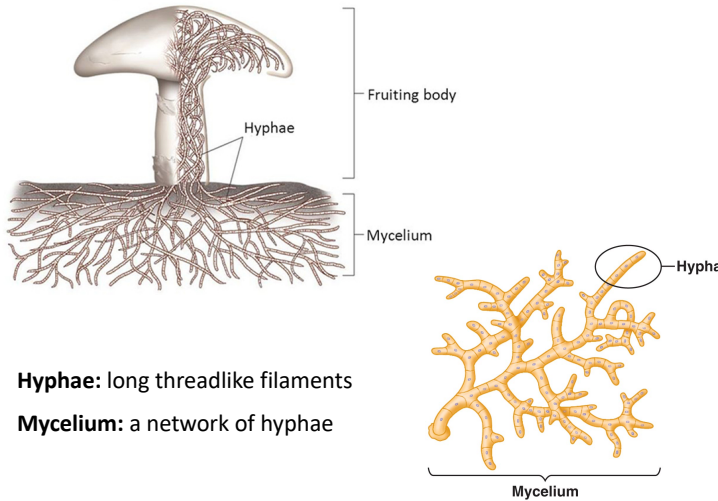
2) Molds



3) Mushroom fungi



Structure of a Typical Fungus



Photos: Dr. Shannon Berch

Wood decomposer fungus (sulphur shelf)

Pathogenic fungus
Armillaria root rot



Litter decomposer fungus (*Mycena*)

Fungus trivia

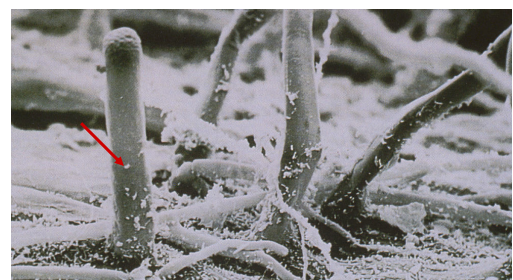
The largest living organism on Earth might be a **honey fungus (*Armillaria*)** in the Malheur National Forest, OR. It's estimated that it covers more than 8.8 km² (~3.7 km across)



Photo: FlWBol/Getty Images

Bacteria - the most diverse and abundant group. They:

- form symbiotic associations with roots of legumes & trees (alder) => N-fixing bacteria
- decompose organic matter by participating in nitrification process (nitrifying bacteria)
- convert nitrate to nitrogen (N₂) or nitrous oxide (N₂O) gas (denitrifying bacteria)



Actinobacteria (formerly known as actinomycetes) are “filamentous bacteria” that:

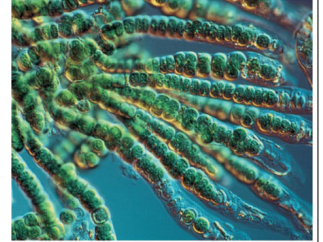
- decompose soil organic compounds (chitin & cellulose);
- produce antibiotics

<https://www.facebook.com/exploristscience/videos/1172282529536608/>



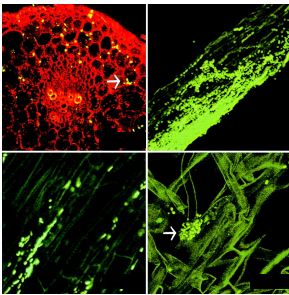
Cyanobacteria (formerly known as blue-green algae)

- Have chlorophyll and perform photosynthesis
- Some can fix atmospheric N (*Anabaena* sp.)
- Some are symbionts with lichens, protozoa, diatoms, algae

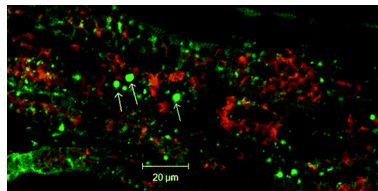


Cyanobacteria 40 μm

Endophytic Bacteria



Endophyte - 'endo' + 'phyte'
 'endo' means within
 'phyte' means plant



Source: Puri A, Padda KP, Chamway CP (2017) Beneficial effects of bacterial endophytes on forest tree species. In: Maheshwari DK, Annapurna K (eds) Endophytes: Crop Productivity and Protection. Springer International Publishing, Switzerland. pp. 111-132.

Main functions:

- Fix atmospheric nitrogen
- Modulate plant hormone levels to:
 - Increase plant growth/yield
 - Protect against abiotic stresses (drought stress, heat/cold stress)
- Provides protection against plant pathogens