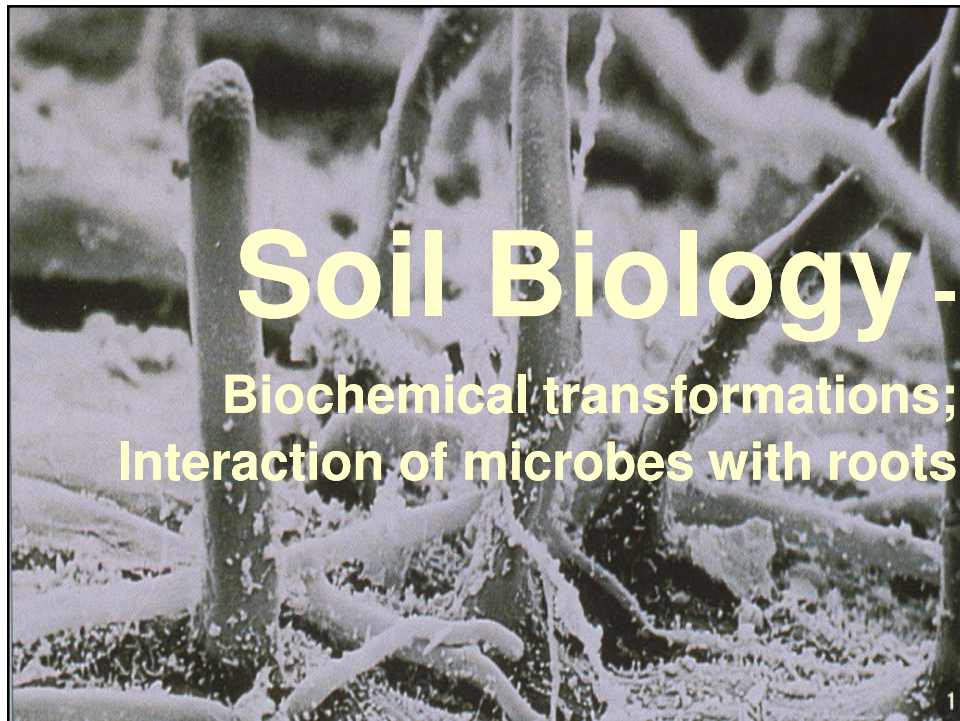




**APBI200
SOIL BIOLOGY & NUTRIENTS**



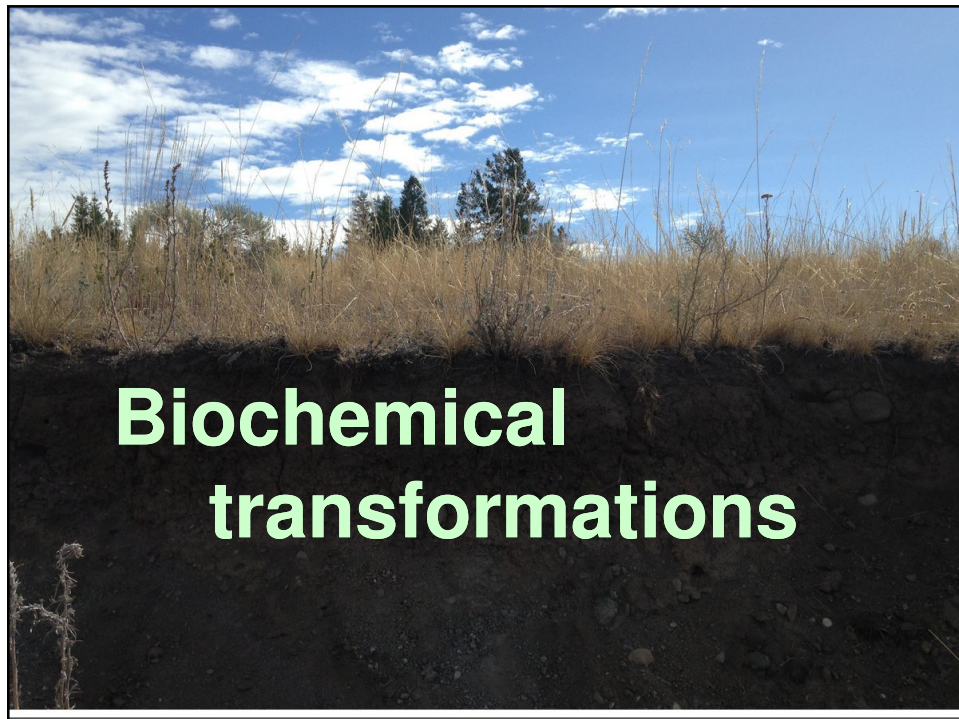
Soil Biology -

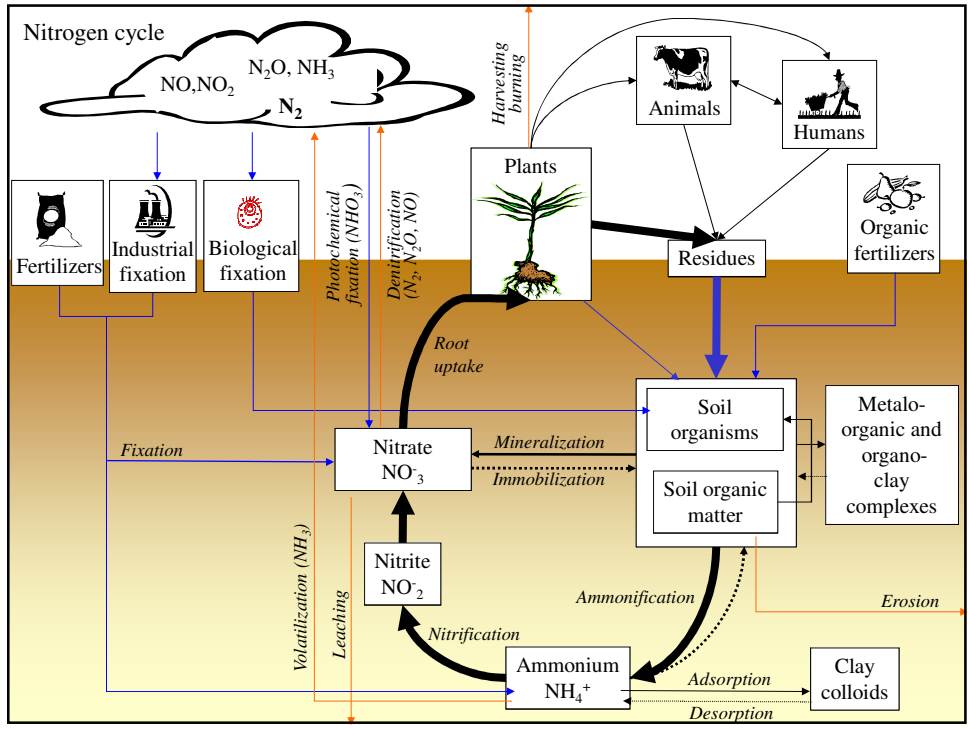
**Biochemical transformations;
Interaction of microbes with roots**

Lecture outline

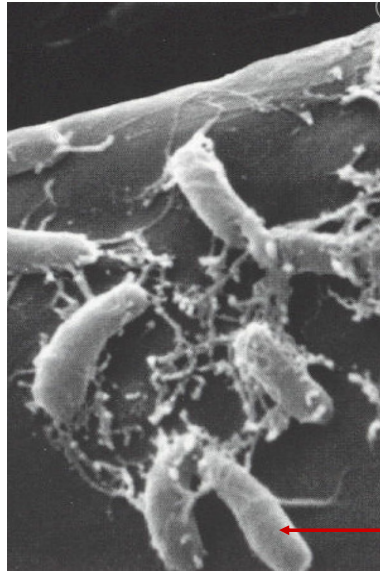
- Biochemical transformations
 - Example #1: Biological N fixation
 - Example #2: Mineralization / Immobilization
 - Example #3: Denitrification
- Microbe interactions with plant roots

3





Example #1 - Biological fixation of N

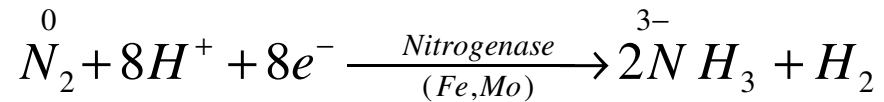


Biological conversion of N_2 gas to ammonia (NH_3) by some bacteria, cyanobacteria, and actinobacteria (formerly known as actinomycetes)

N fixing bacteria generate cellulose as they attach to the root hair 6

Example #1 – cont.

Biological N fixation



Estimated amount of N fixation in terrestrial ecosystems is ~139 million t N per year

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Example #1 – cont.

Typical levels of biological N fixation

Crop or plant	Associated organism	Typical level of N fixation (kgN/ha/yr)
<u>Symbiotic</u>		
Legumes (nodulated)		
Alfalfa	Bacteria (<i>Rhizobium</i>)	150 – 250
Clover	Bacteria (<i>Rhizobium</i>)	100 – 150
Vetch	Bacteria (<i>Rhizobium</i>)	50 – 150
Non-legumes (nodulated)		
Alders (<i>Alnus sp.</i>)	Actinobacteria (<i>Frankia</i>)	50 – 150
Non-legumes (non-nodulated)		
Bahia grass	Bacteria (<i>Azotobacter</i>)	5 – 30
<u>Non-symbiotic</u>		
Not involved with plants	Bacteria (<i>Azotobacter</i> , <i>Clostridium</i>)	5 - 20

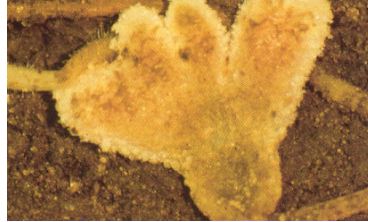
8

Example #1 – cont.

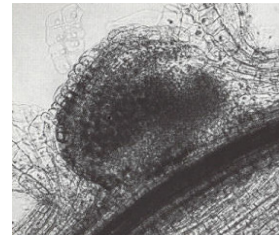
Symbiotic N fixers with legumes (nodulated)



Soybean nodules are spherical



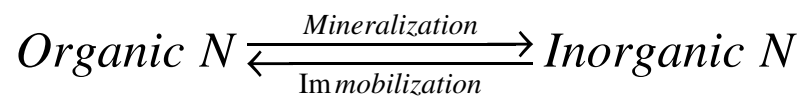
Alfalfa nodules may grow multiple lobes



This newly emerged white clover root nodules will soon begin fixing N

Example #2

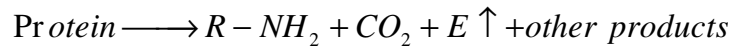
Mineralization / Immobilization



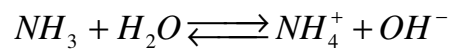
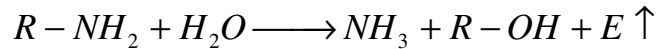
Example #2

Mineralization:

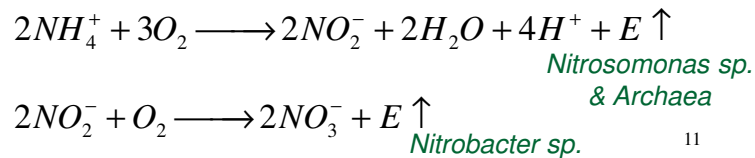
- **Aminization**



- **Ammonification**



- **Nitrification**



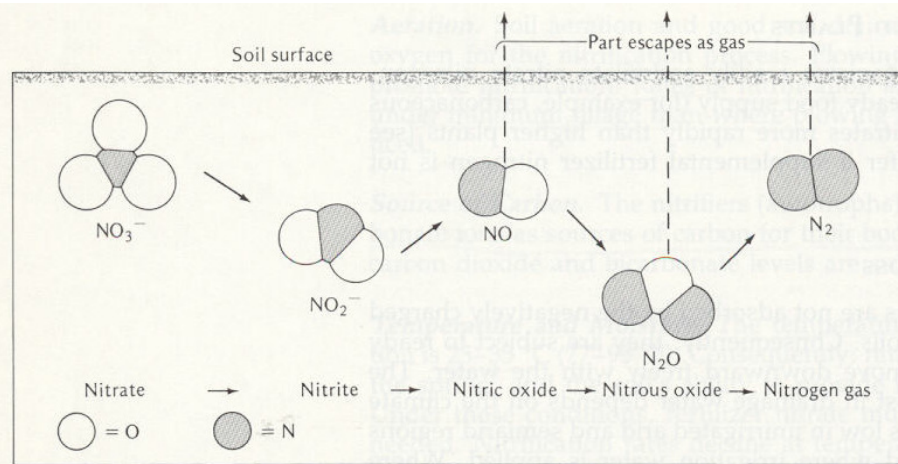
Example #2

Mineralization and microbes involved

- **Aminization** → heterotrophs (bacteria and fungi)
- **Ammonification** → heterotrophs (bacteria, actinobacteria, fungi)
- **Nitrification** → chemo-autotrophic bacteria & archaea

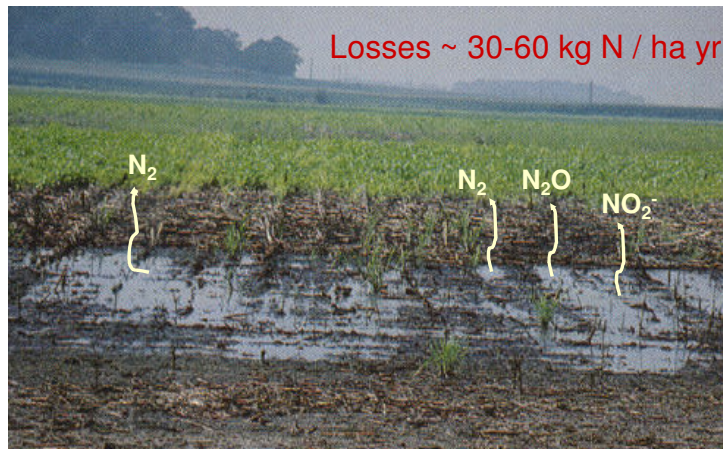
Example #3

Denitrification – biological reduction of NO_3^- to gaseous compounds



Example #3

Denitrification bacteria live under anaerobic conditions, such as those in saturated, compacted soils

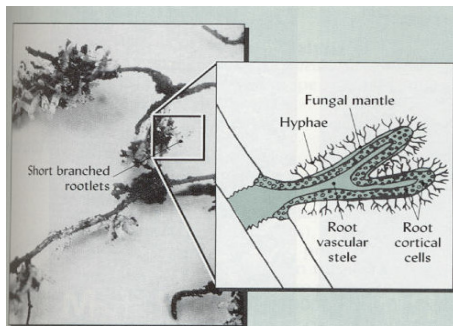




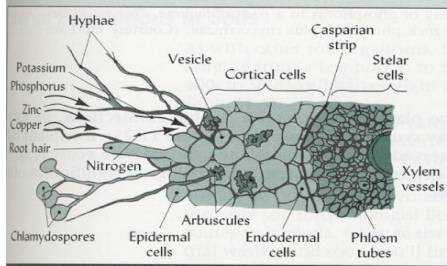


Mycorrhizae is a mutually beneficial, symbiotic association between plants and fungi, where fungus provides nutrients, while plant provides sugars from photosynthesis

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(a) **Ectomycorrhiza**



(b) **Endomycorrhiza**

Types of mycorrhizae:

- Ectomycorrhiza with tree sp. except our 'cedars'
- Ericoid mycorrhiza with Ericaceae (blueberry, salal)
- Arbuscular mycorrhiza with most other plants

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mycorrhizal plants

nonmycorrhizal plants

Photos: Shannon Berch

Arbuscular mycorrhiza

arbuscules

Ericoid mycorrhiza

colonized cells

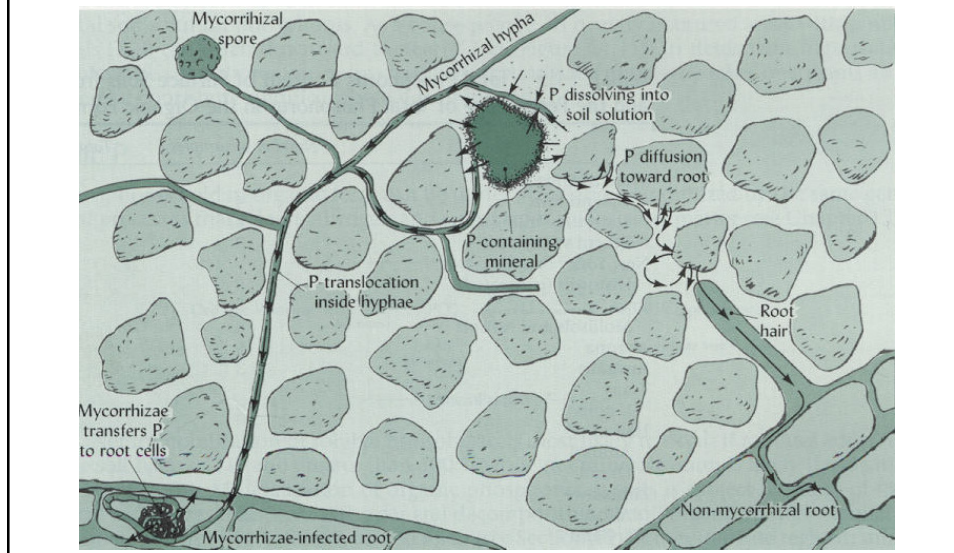
uncolonized cell

Photos: Shannon Berch

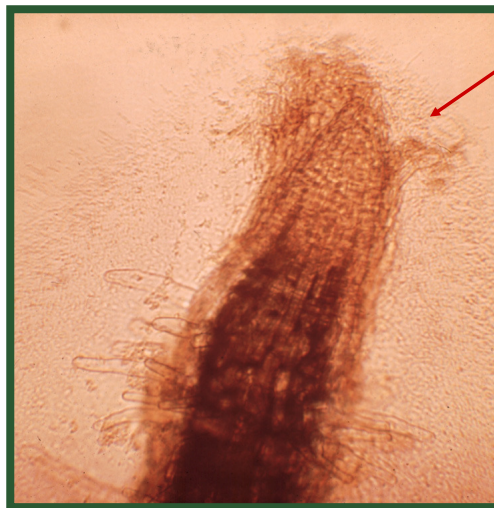
salal on cutblock

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Role of mycorrhizal hyphae in the movement of phosphate ions to plant roots



Rhizosphere effects



Dead cells and exudates released from a corn root

Rhizosphere is the space near roots where microbes (e.g. bacteria) feed on dead root cells and exudates (sugars, proteins)

Jan/Feb 2011 issue of Canadian Geographic

How Avatar got it right: “Mother trees” use fungal systems to feed the forest – article featuring work of Dr. Suzanne Simard (Faculty of Forestry)

http://www.canadiangeographic.ca/magazine/jf11/fungal_systems.asp