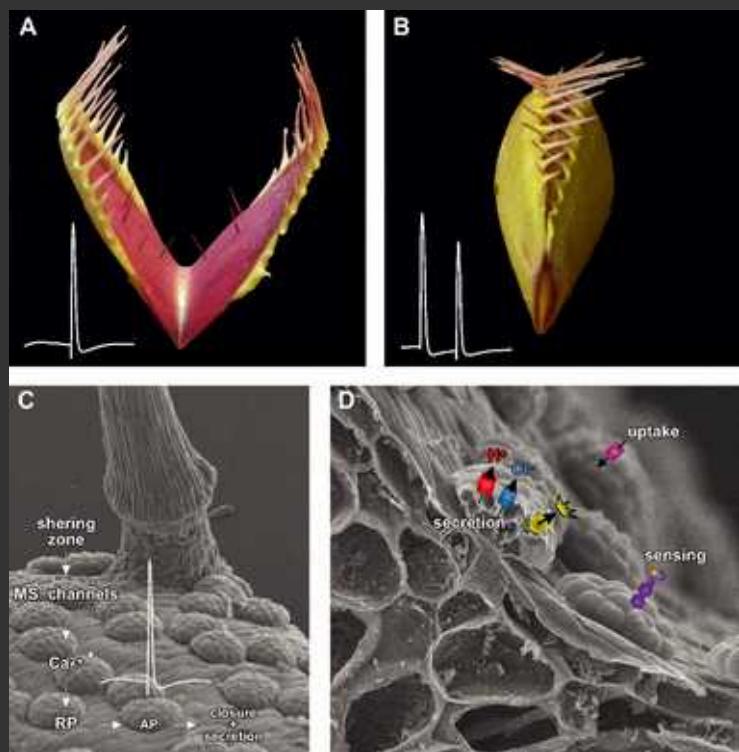
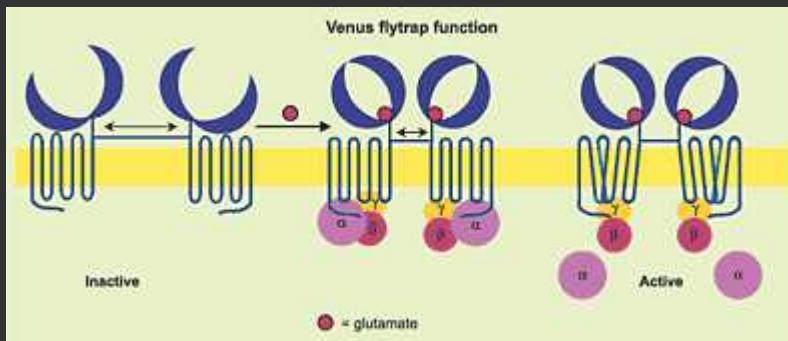


Carnivorous plants

- Why do some plants eat animals?
- Why might we care about plant conservation?
- How did plant carnivory evolve?
- Where do carnivorous plants live....and why not other places?
- What major nutrients do plants need and in what forms?
- What is soil? Can you describe aspects of its complexity?
- What processes are going on at the interface of plant roots and soil?

Bonus Question: Why aren't koalas considered true bears?



Electrical Signal after Mechanical Trigger Hair Stimulation

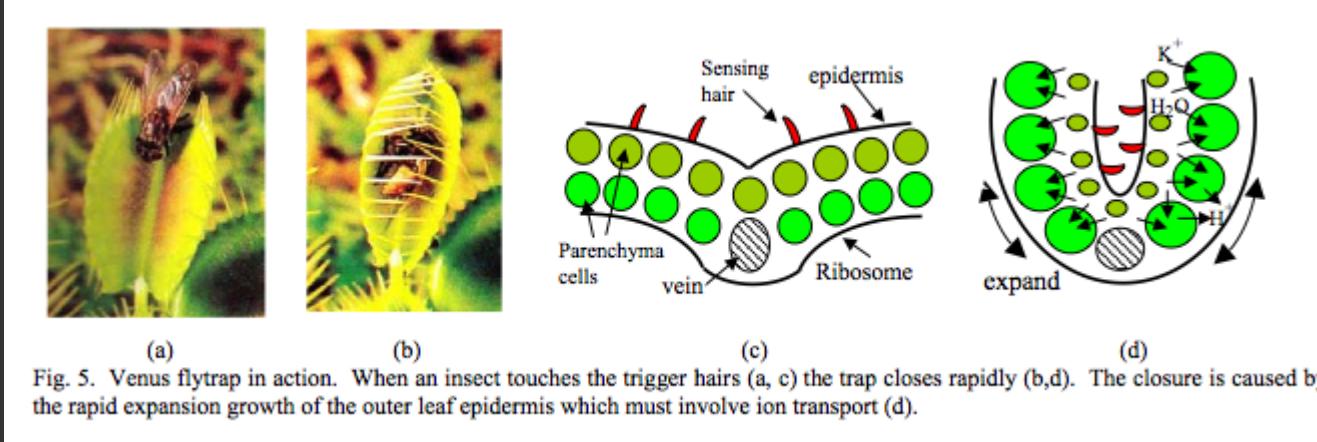
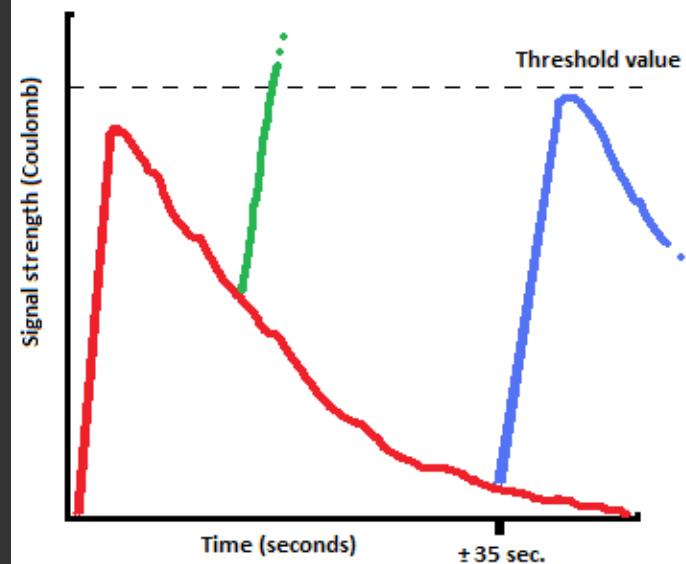
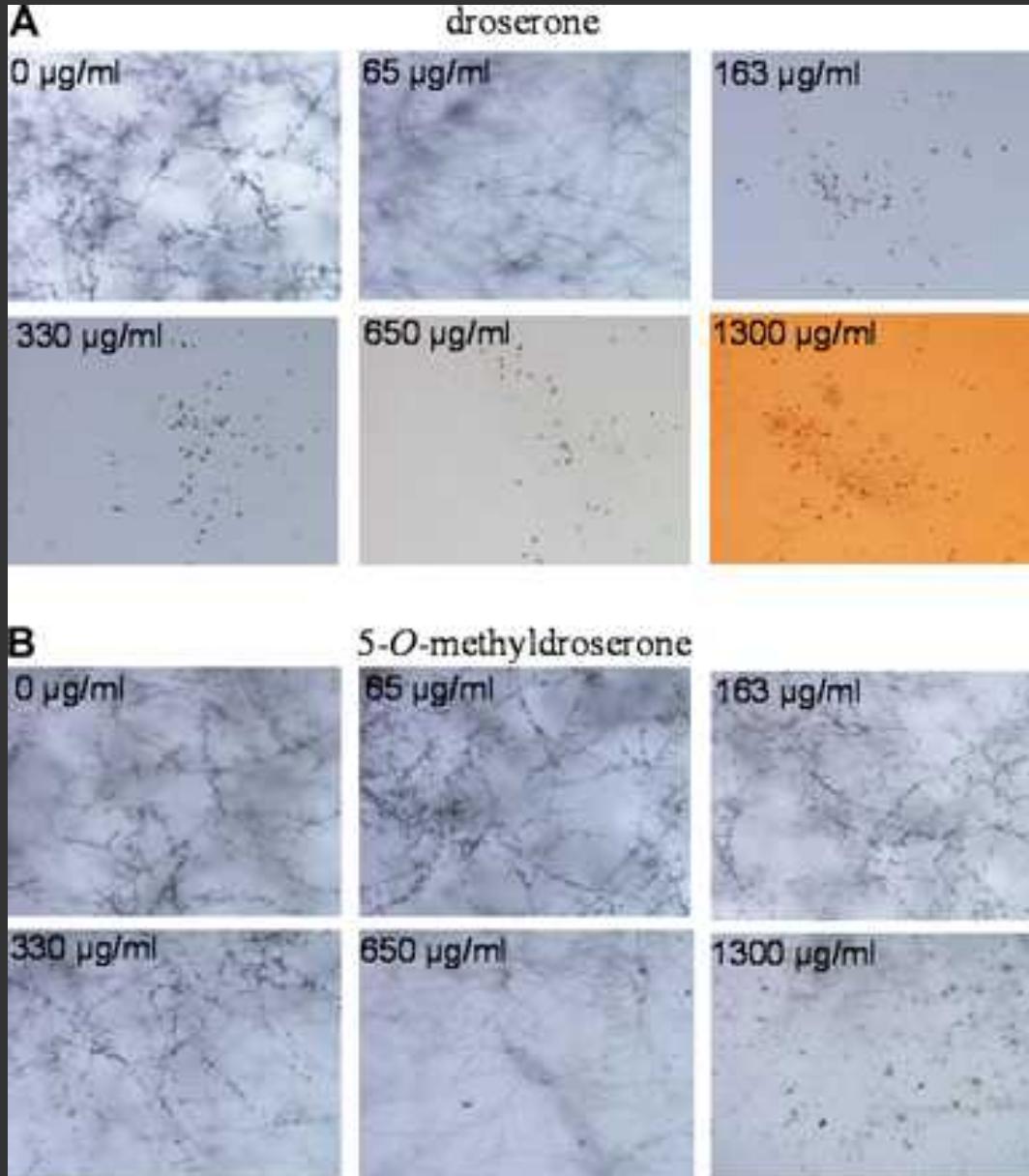


Fig. 5. Venus flytrap in action. When an insect touches the trigger hairs (a, c) the trap closes rapidly (b,d). The closure is caused by the rapid expansion growth of the outer leaf epidermis which must involve ion transport (d).

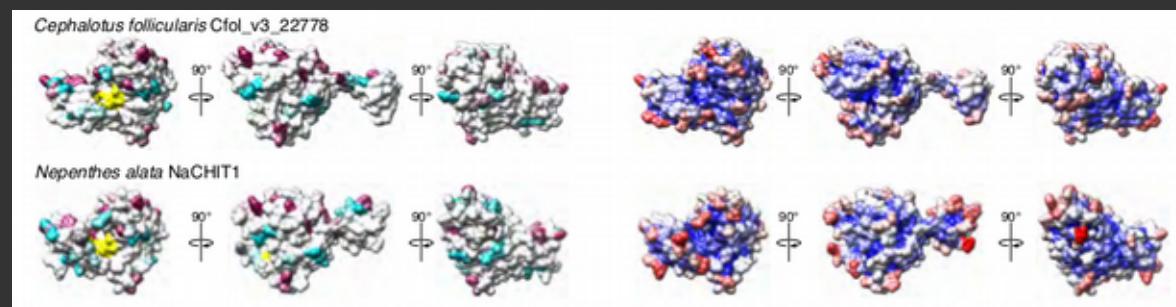
Carniverous plants are rare and some are endangered.

- Who gives a crap!?
- If they are rare they aren't important to the ecosystem.
- Can you make an argument for why we should spend money/time conserving them?

Our latest and best antifungal drug comes from carnivorous plant enzymes



Evolution of plant carnivory



Chitinase can fight off fungal infections...and digest insect exoskeletons

What are the costs of carnivory?

Where are carnivorous plants found?



What is it like there?

Type of peat	Depth (cm)	Total organic matter	Water soluble compounds	Ether/alcohol soluble materials	Hemi-cellulose	Cellulose	Lignin and derivates	Nitrogenous compounds
Sphagnum (Main, USA ¹)	20–36	95.7	5.2	7.8	24.1	17.1	18.0	0.8
Saw-grass (Florida, USA ¹)	80	93.3	2.1	2.3	4.4	2.2	60.1	3.5
Woody sedge (Washington, USA ¹)	25–40	93.5	5.9	7.7	7.0	3.2	38.2	3.3
Papyrus (Israel ²)	50–100	77.3	7.9	1.7	8.0			
Forest woody (Sumatra, Indonesia ³)	subsurface layer	97.0	1.9	9.4	2.0			
Forest woody (Borneo, Indonesia ³)	subsurface layer	98.6	0.9	9.0	2.0			
Papyrus vegetation ²		9.6	4.0	21.5				



Carniverous plants succeed only where other plants fail.

Bog soils tend to be:

Acidic

Very low nutrient availability (why?)

Low or no oxygen

Consistently wet



Why do some plants eat insects?



What nutrients do plants need?



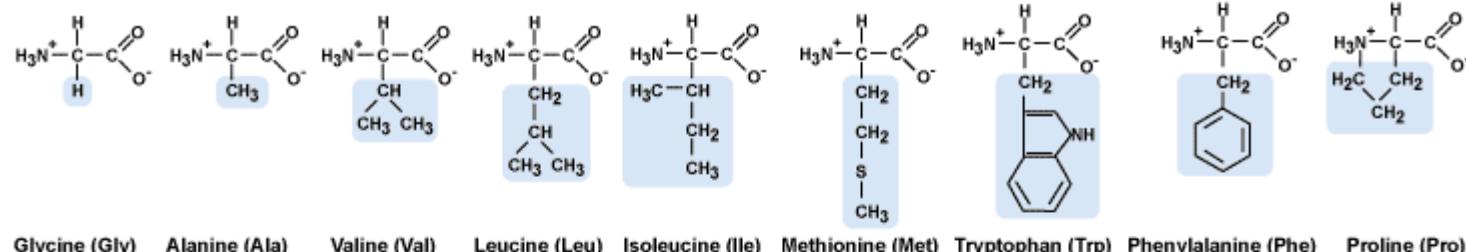
Plant nutrition

Table 37.1 Essential Elements in Plants

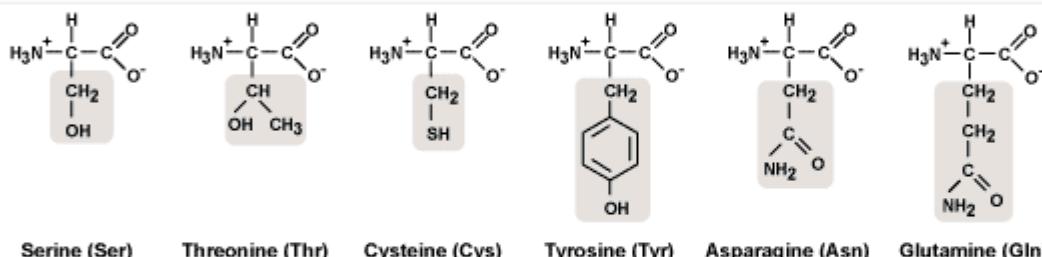
Element	Form Available to Plants	% Mass in Dry Tissue	Major Functions
Macronutrients			
Carbon	CO ₂	45%	Major component of plant's organic compounds
Oxygen	CO ₂	45%	Major component of plant's organic compounds
Hydrogen	H ₂ O	6%	Major component of plant's organic compounds
Nitrogen	NO ₃ ⁻ , NH ₄ ⁺	1.5%	Component of nucleic acids, proteins, hormones, chlorophyll, coenzymes
Potassium	K ⁺	1.0%	Cofactor that functions in protein synthesis; major solute functioning in water balance; operation of stomata
Calcium	Ca ²⁺	0.5%	Important in formation and stability of cell walls and in maintenance of membrane structure and permeability; activates some enzymes; regulates many responses of cells to stimuli
Magnesium	Mg ²⁺	0.2%	Component of chlorophyll; activates many enzymes
Phosphorus	H ₂ PO ₄ ⁻ , HPO ₄ ²⁻	0.2%	Component of nucleic acids, phospholipids, ATP, several coenzymes
Sulfur	SO ₄ ²⁻	0.1%	Component of proteins, coenzymes
Micronutrients			
Chlorine	Cl ⁻	0.01%	Required for water-splitting step of photosynthesis; functions in water balance
Iron	Fe ³⁺ , Fe ²⁺	0.01%	Component of cytochromes; activates some enzymes
Manganese	Mn ²⁺	0.005%	Active in formation of amino acids; activates some enzymes; required for water-splitting step of photosynthesis
Boron	H ₂ BO ₃ ⁻	0.002%	Cofactor in chlorophyll synthesis; may be involved in carbohydrate transport and nucleic acid synthesis; role in cell wall function
Zinc	Zn ²⁺	0.002%	Active in formation of chlorophyll; activates some enzymes
Copper	Cu ⁺ , Cu ²⁺	0.001%	Component of many redox and lignin-biosynthetic enzymes
Nickel	Ni ²⁺	0.001%	Cofactor for an enzyme functioning in nitrogen metabolism
Molybdenum	MoO ₄ ²⁻	0.0001%	Essential for symbiotic relationship with nitrogen-fixing bacteria; cofactor in nitrate reduction

Nitrogen

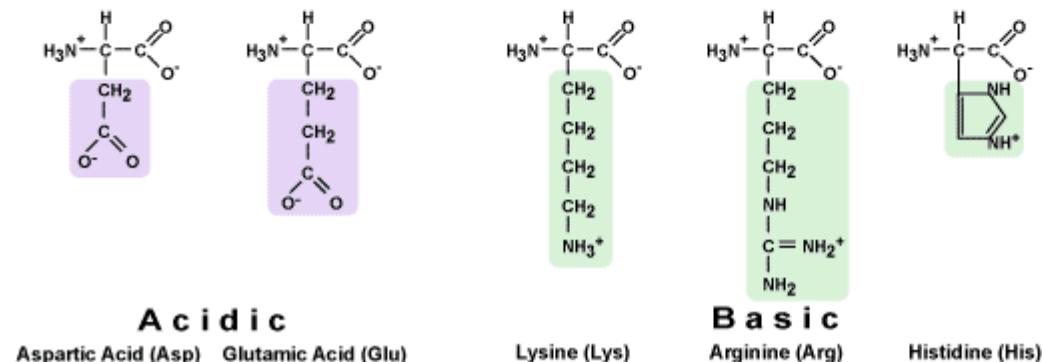
NONPOLAR



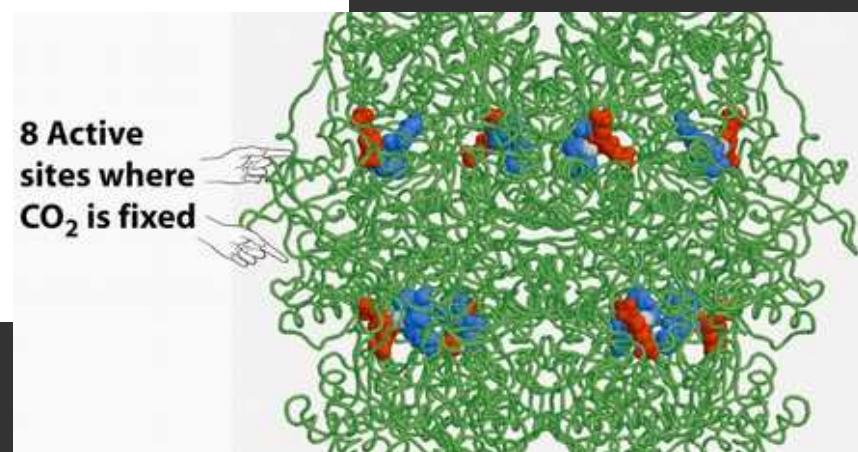
POLAR



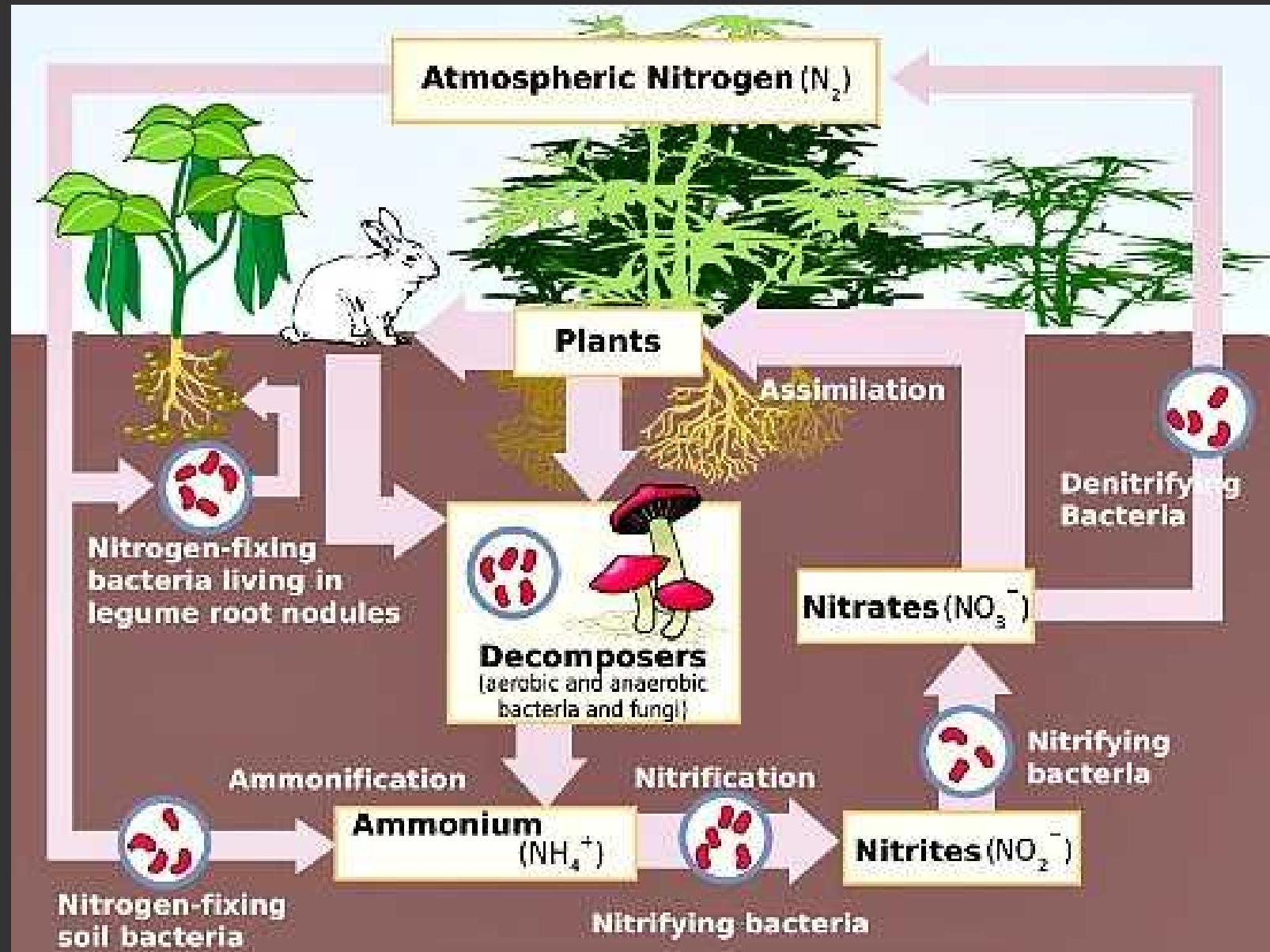
Electrically Charged



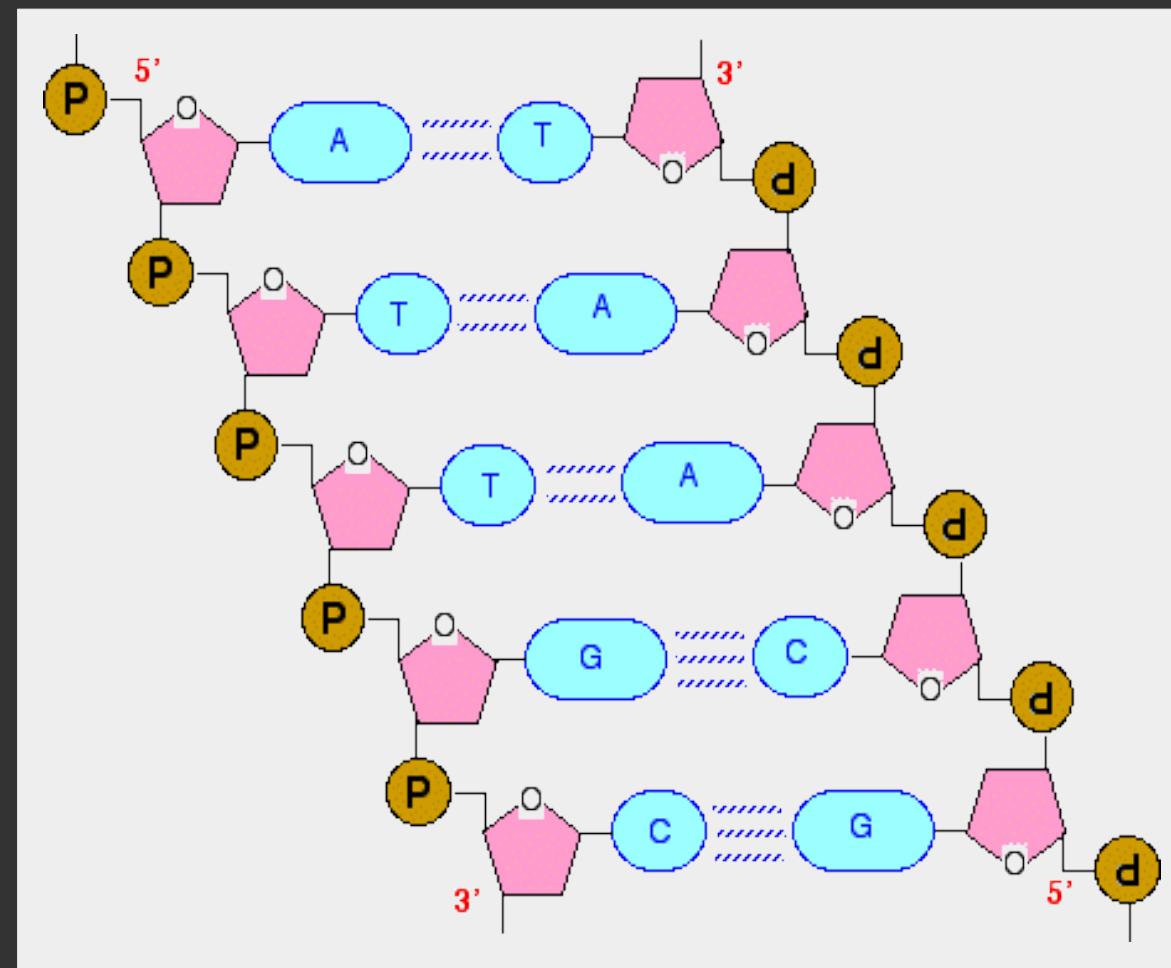
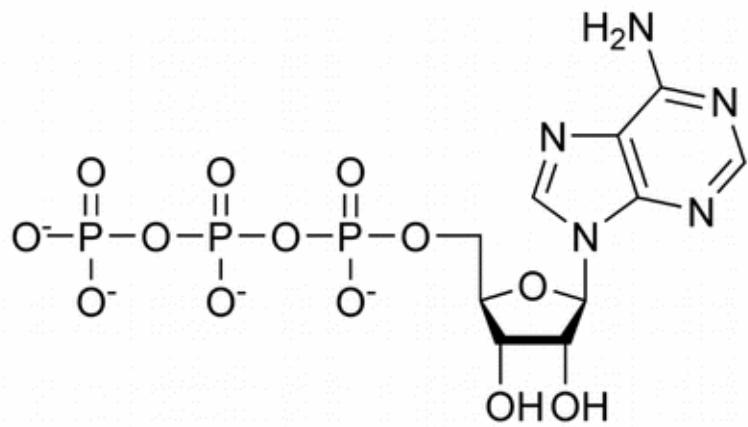
8 Active sites where CO₂ is fixed



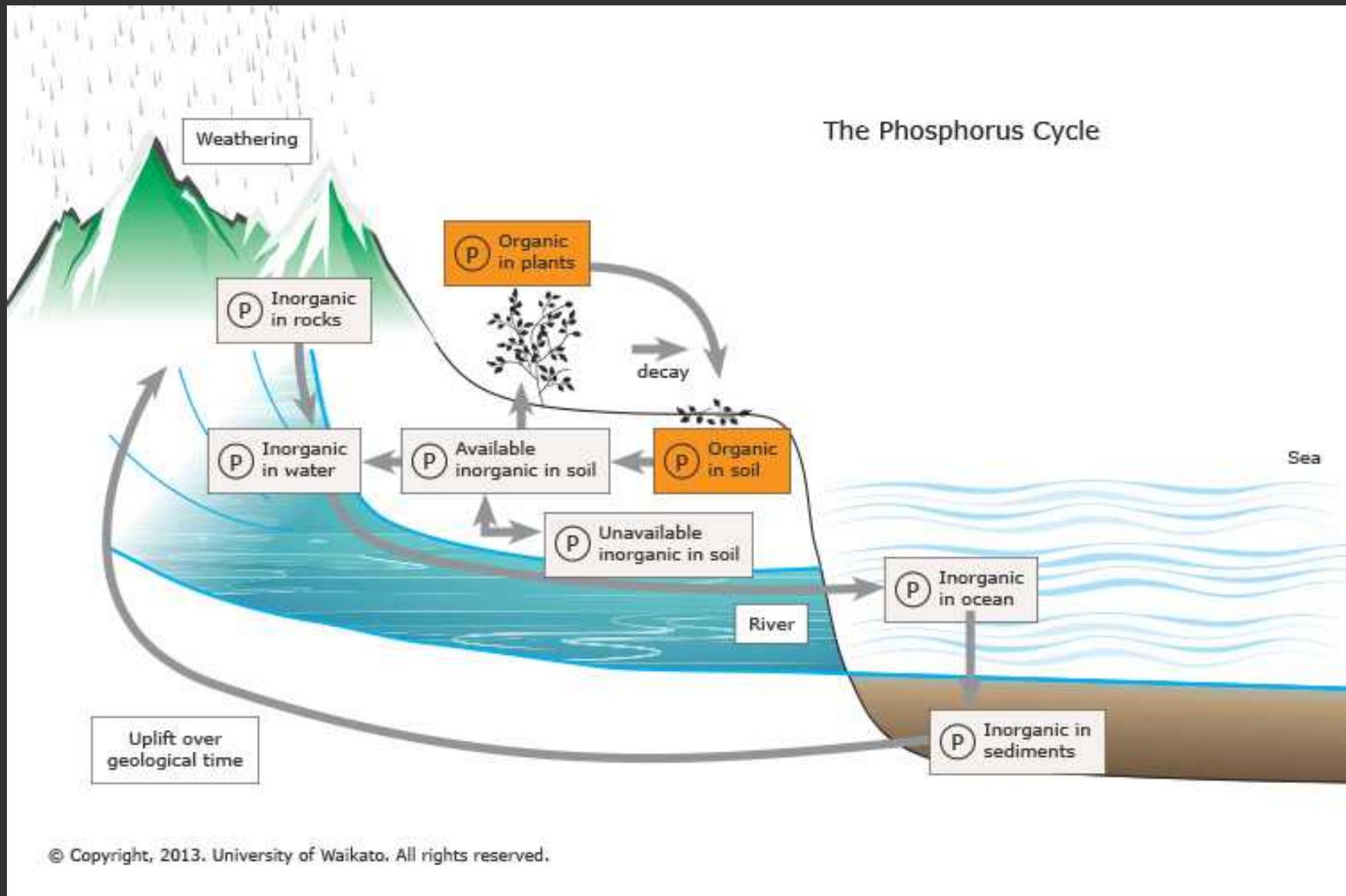
Where does N come from?



Phosphorus



Where does phosphorus come from?



Potassium

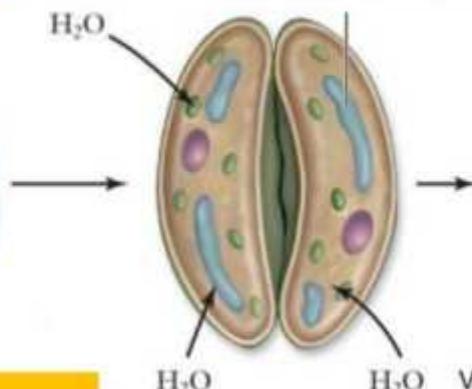
How do stomata open during the day?

Closed stoma:
flaccid guard cells

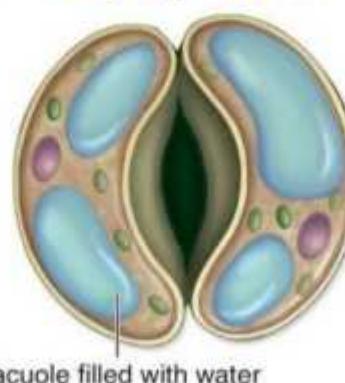


potassium ions
enter the guard cells
& water follows.

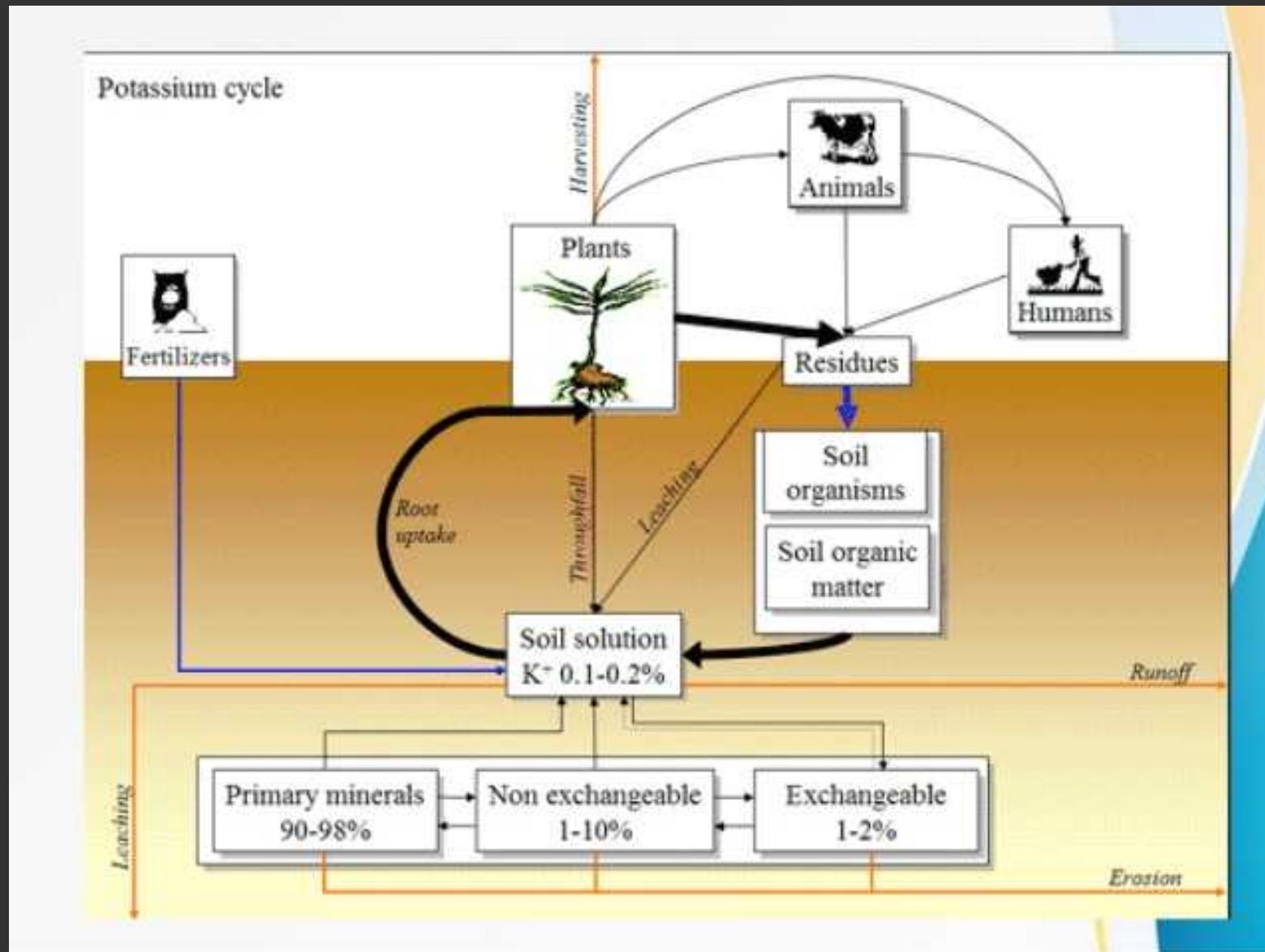
Little water in vacuole



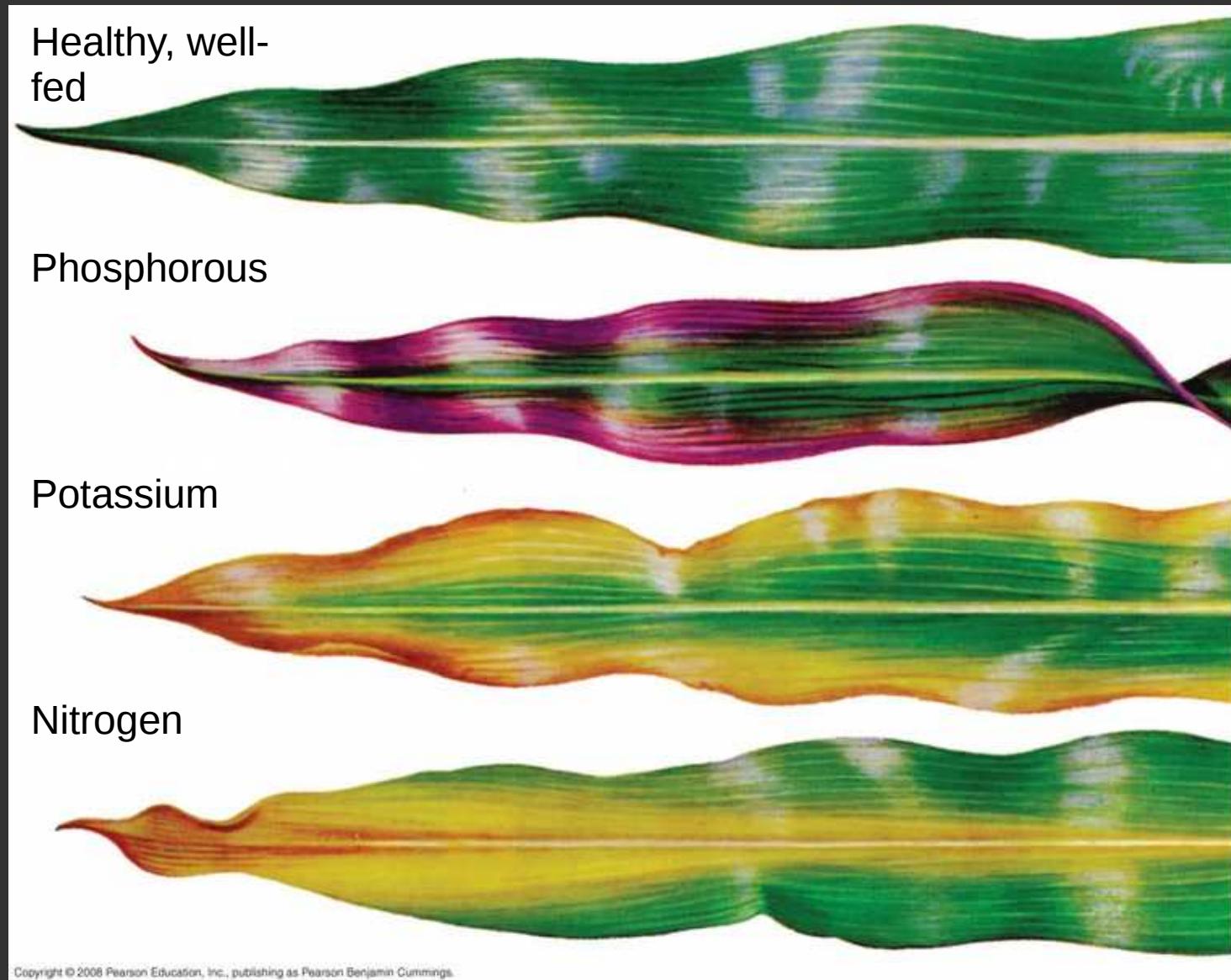
Open stoma:
turgid guard cells



Where does potassium come from?



Nutrient deficiencies



Plants can only use certain forms of NPK

Nitrogen



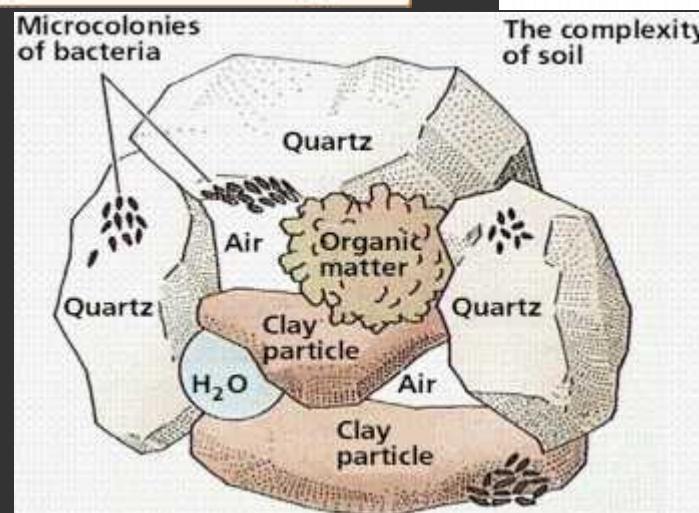
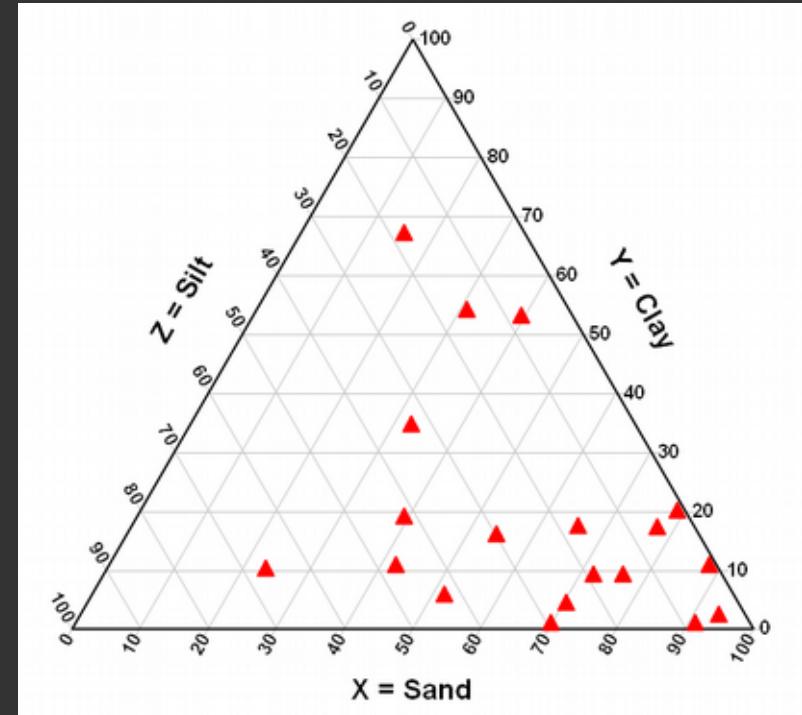
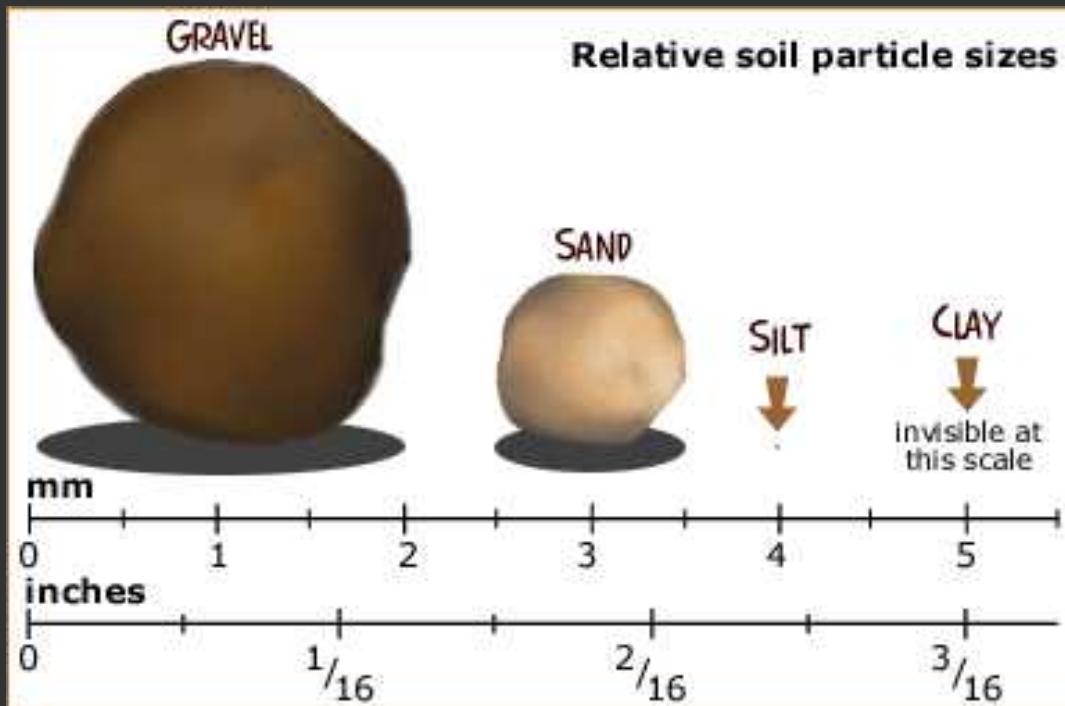
Phosphorous



Potassium



What is soil?



Clay

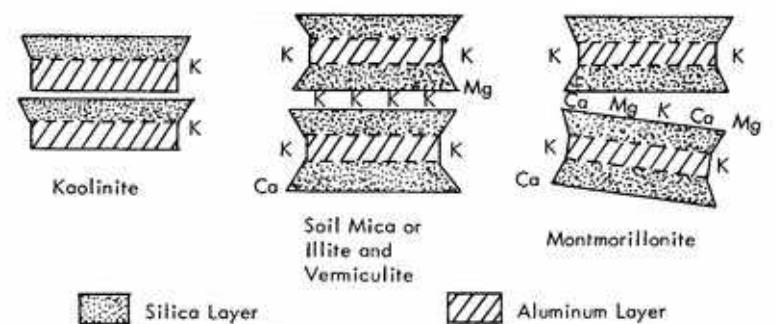
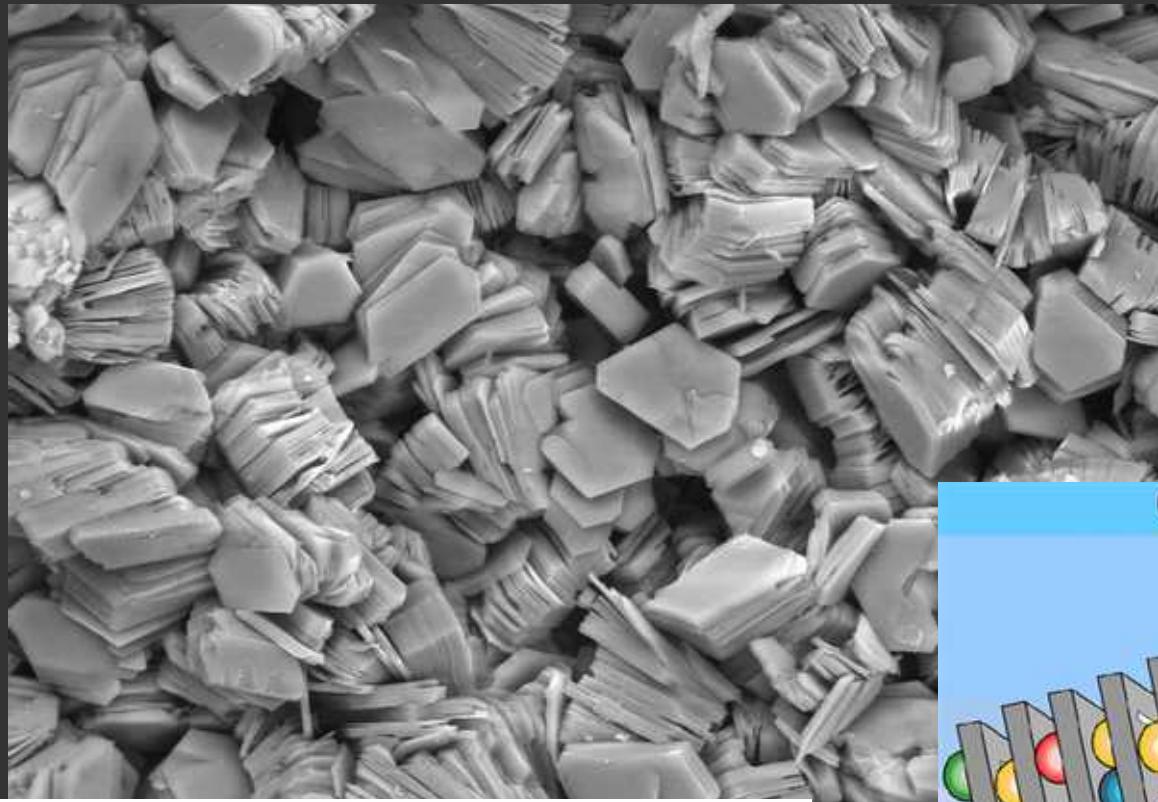
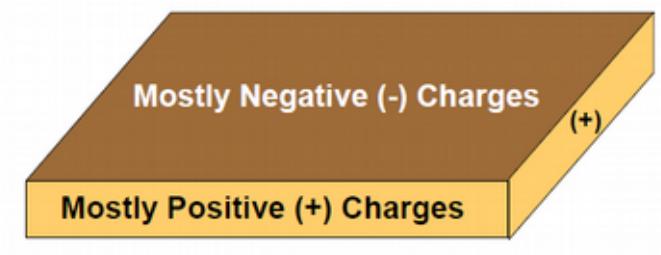
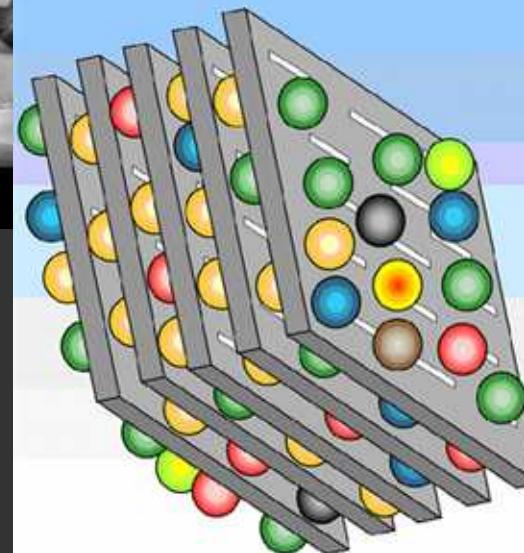


Fig. 3.—The Structure of Four Types of Clay Minerals Found in Kentucky Soils.

Charges on Clay Particles

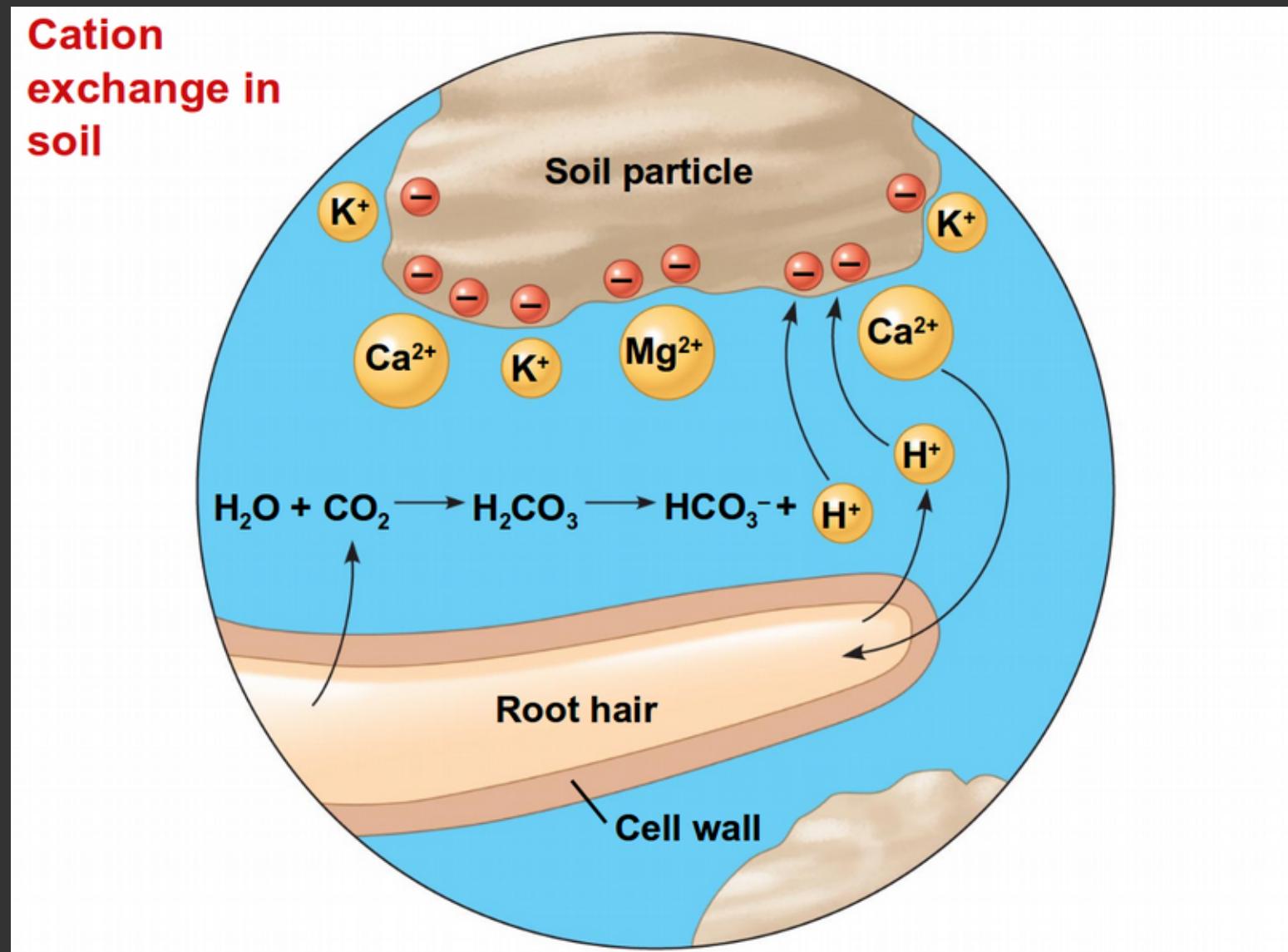


Cation Retention on Soil Clays

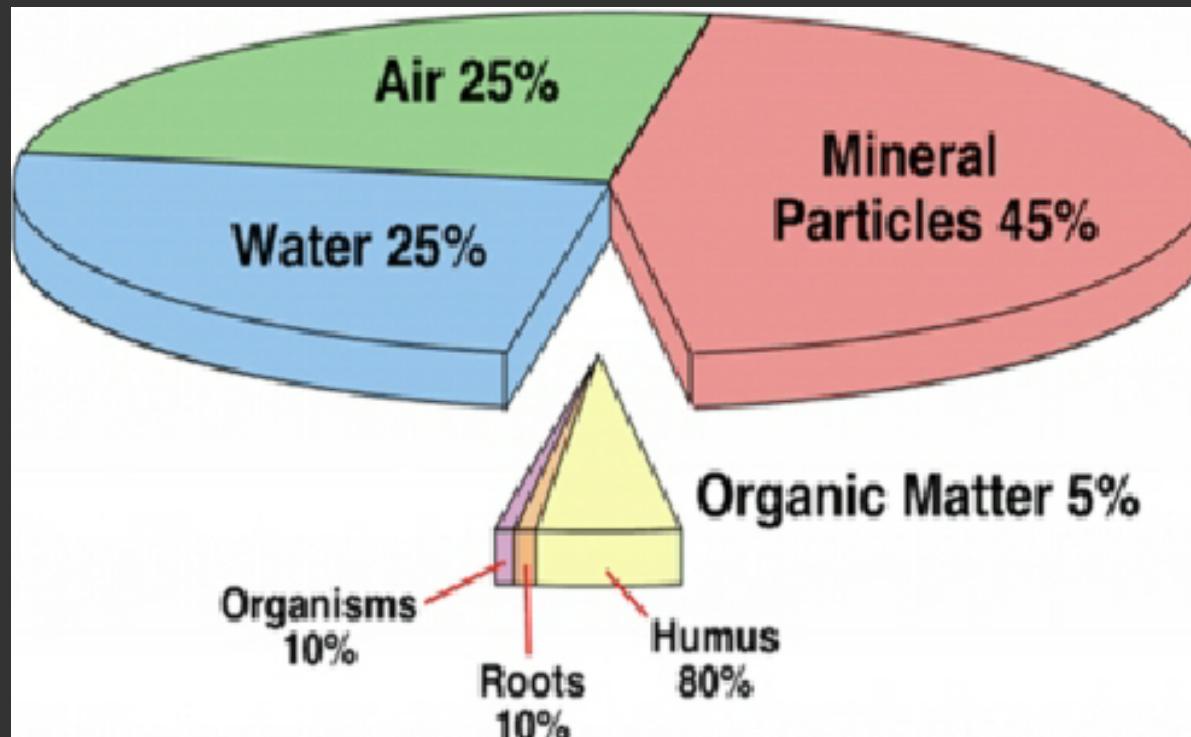


- Calcium, 2⁺
- Magnesium, 2⁺
- Potassium, 1⁺
- Ammonium, 1⁺
- Sodium, 1⁺
- Copper, 2⁺
- Aluminum, 3⁺
- Hydrogen, 1⁺

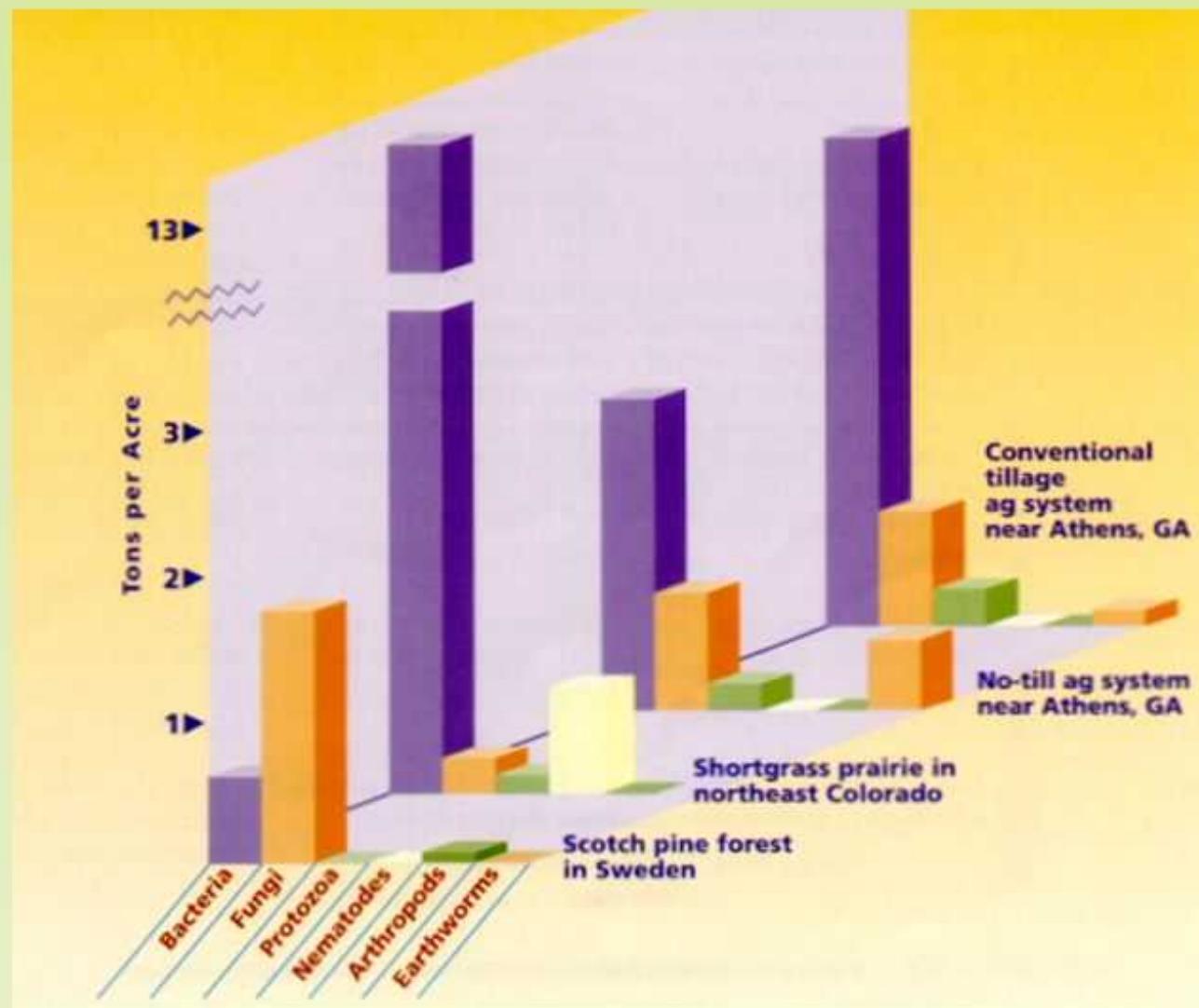
Hydrogen frees ions from soil adhesion



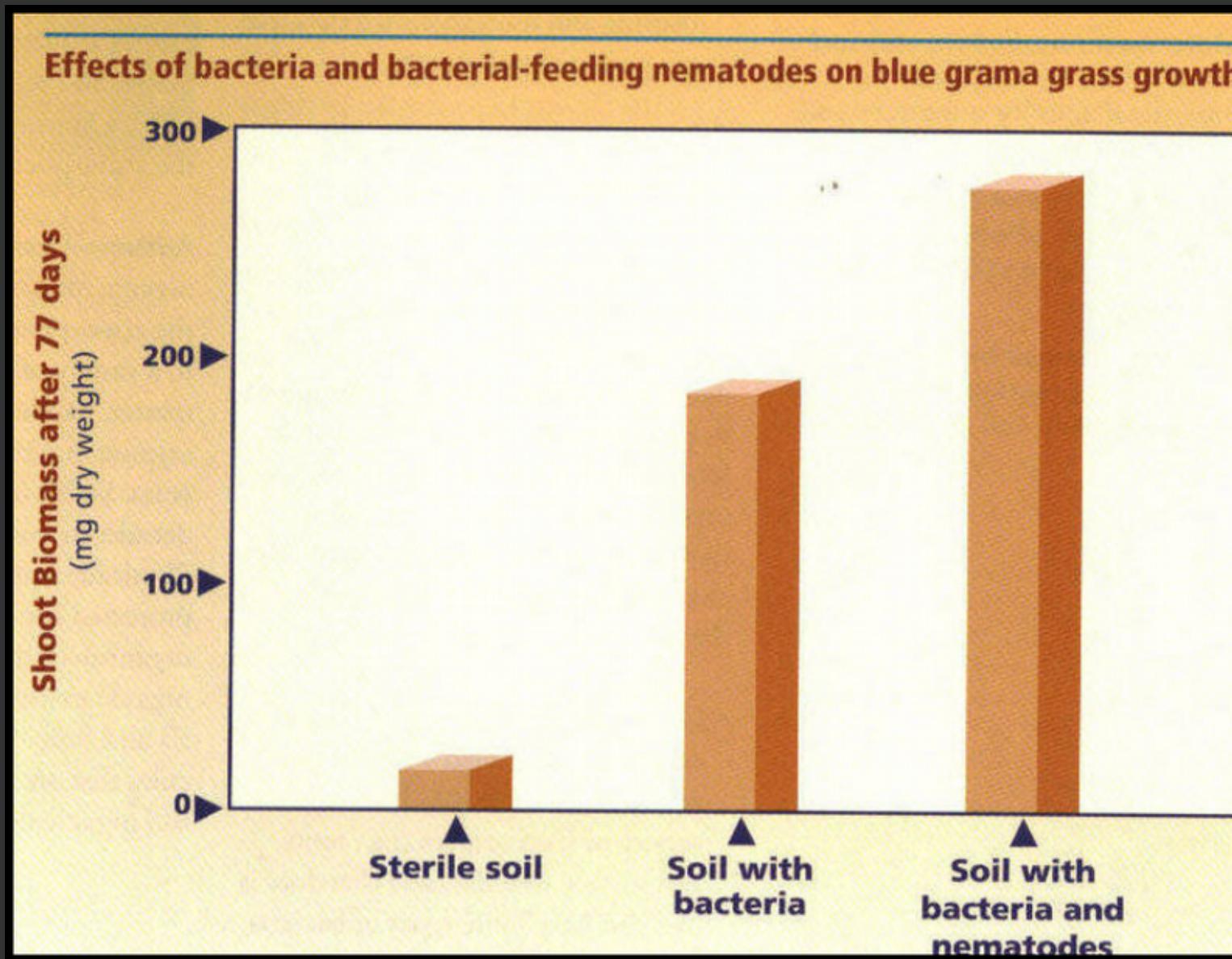
Soil composition by volume



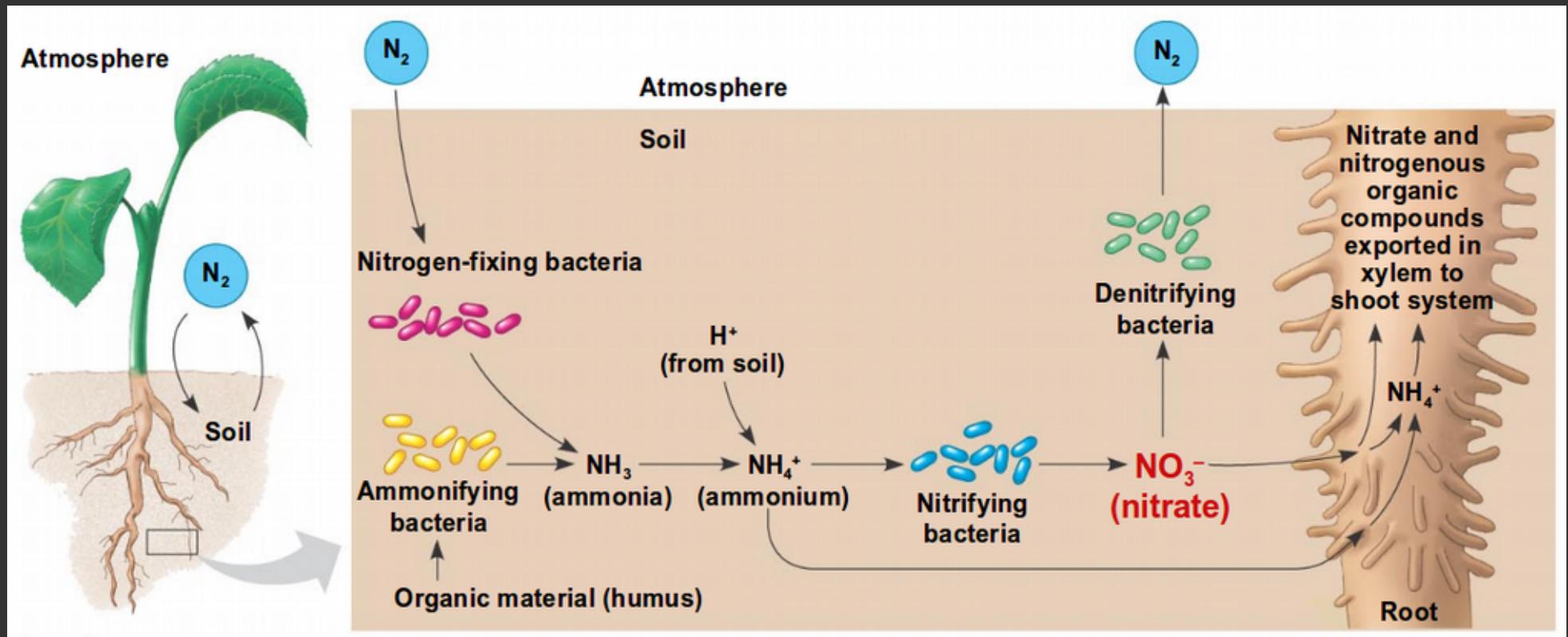
Biomass of Soil Organisms in Four Ecosystems



What is going on here?



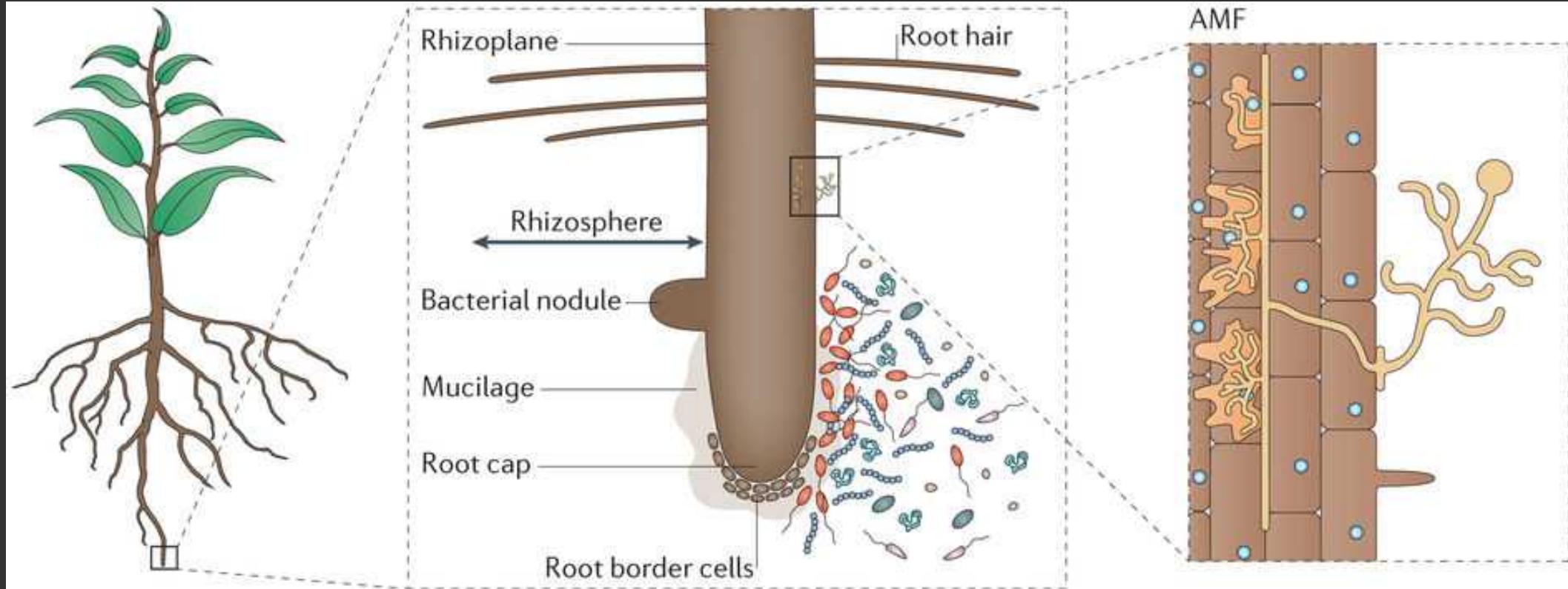
Role of bacteria in plant N acquisition



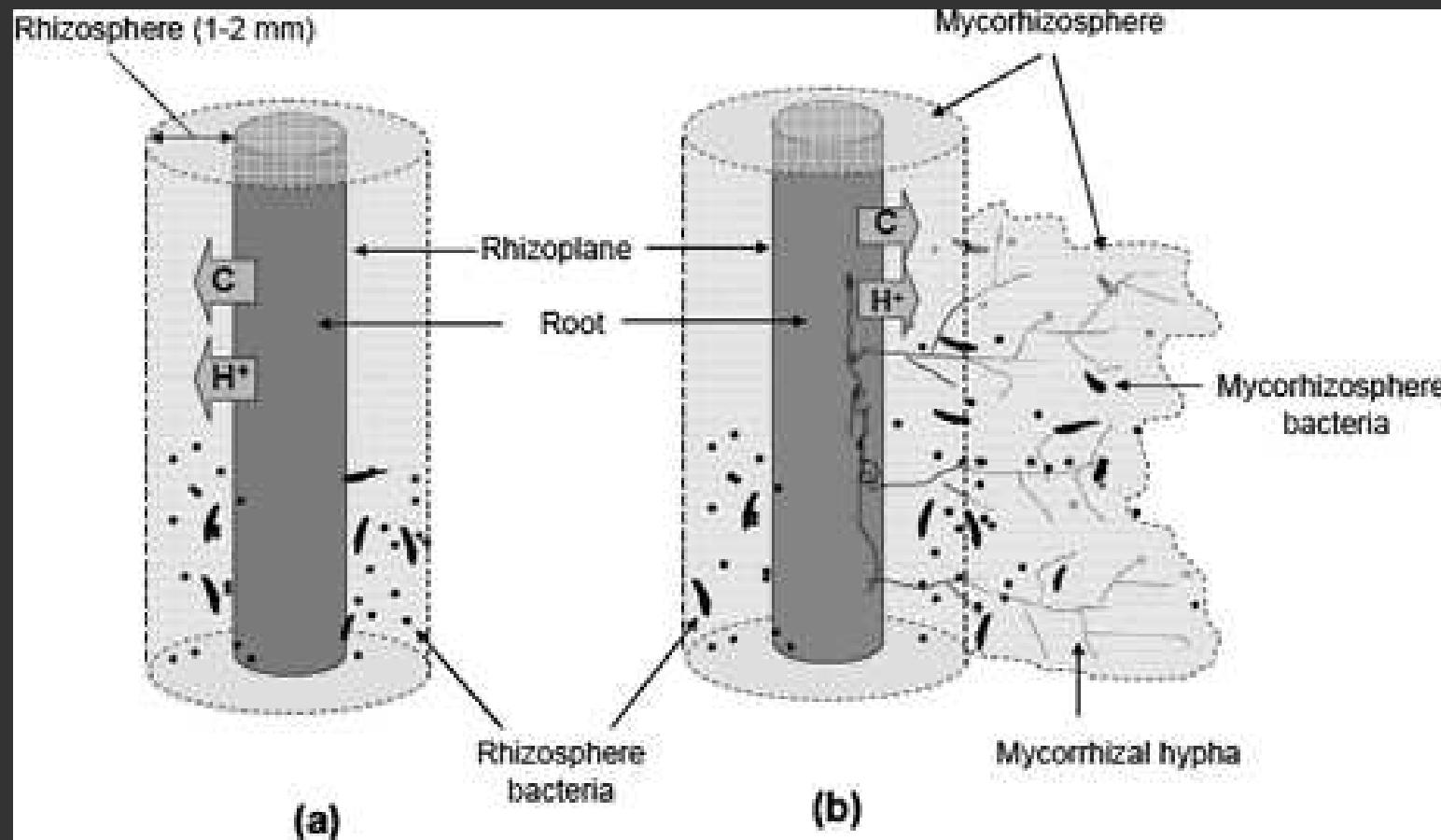
Soil is alive



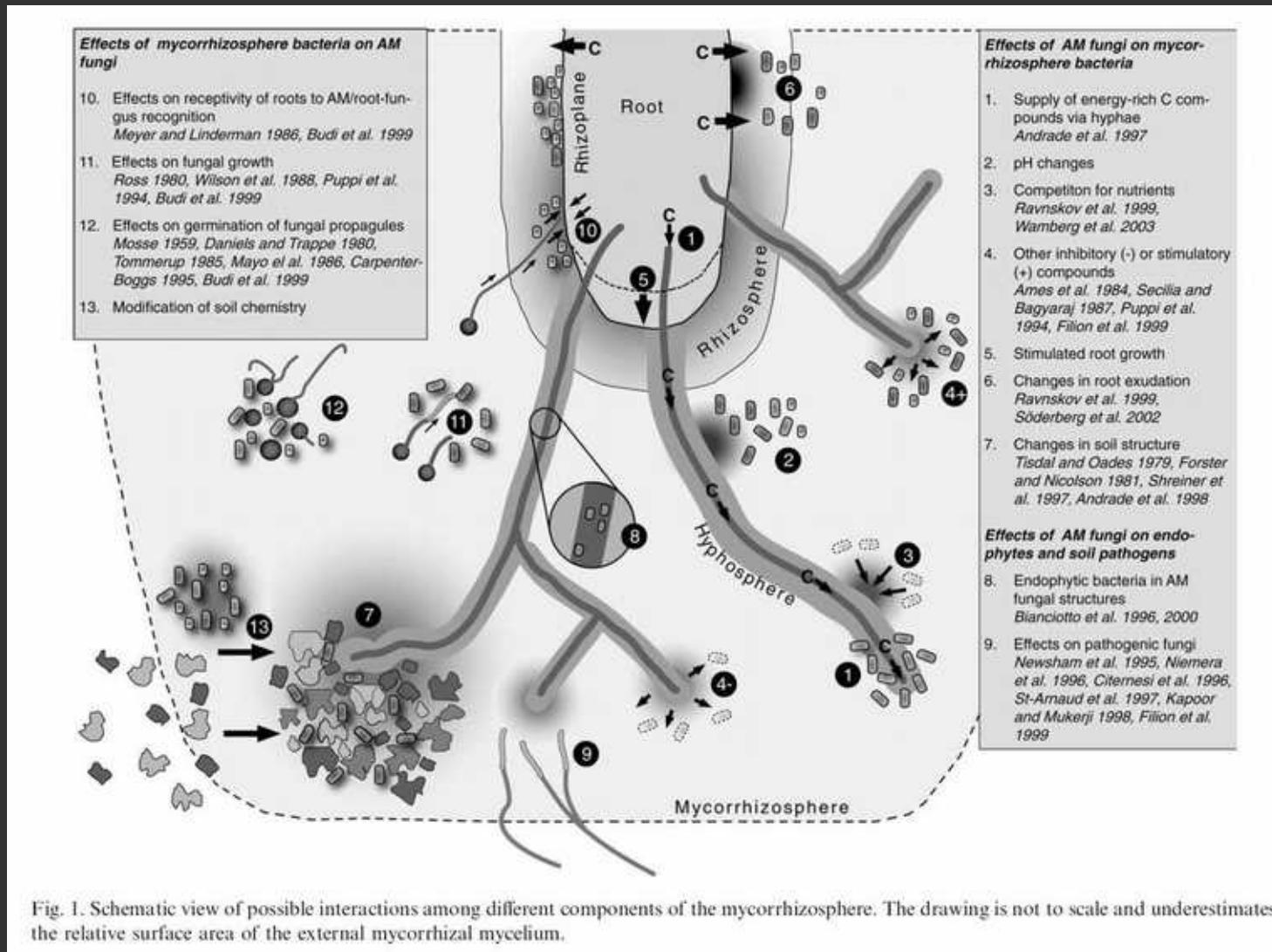
Rhizosphere



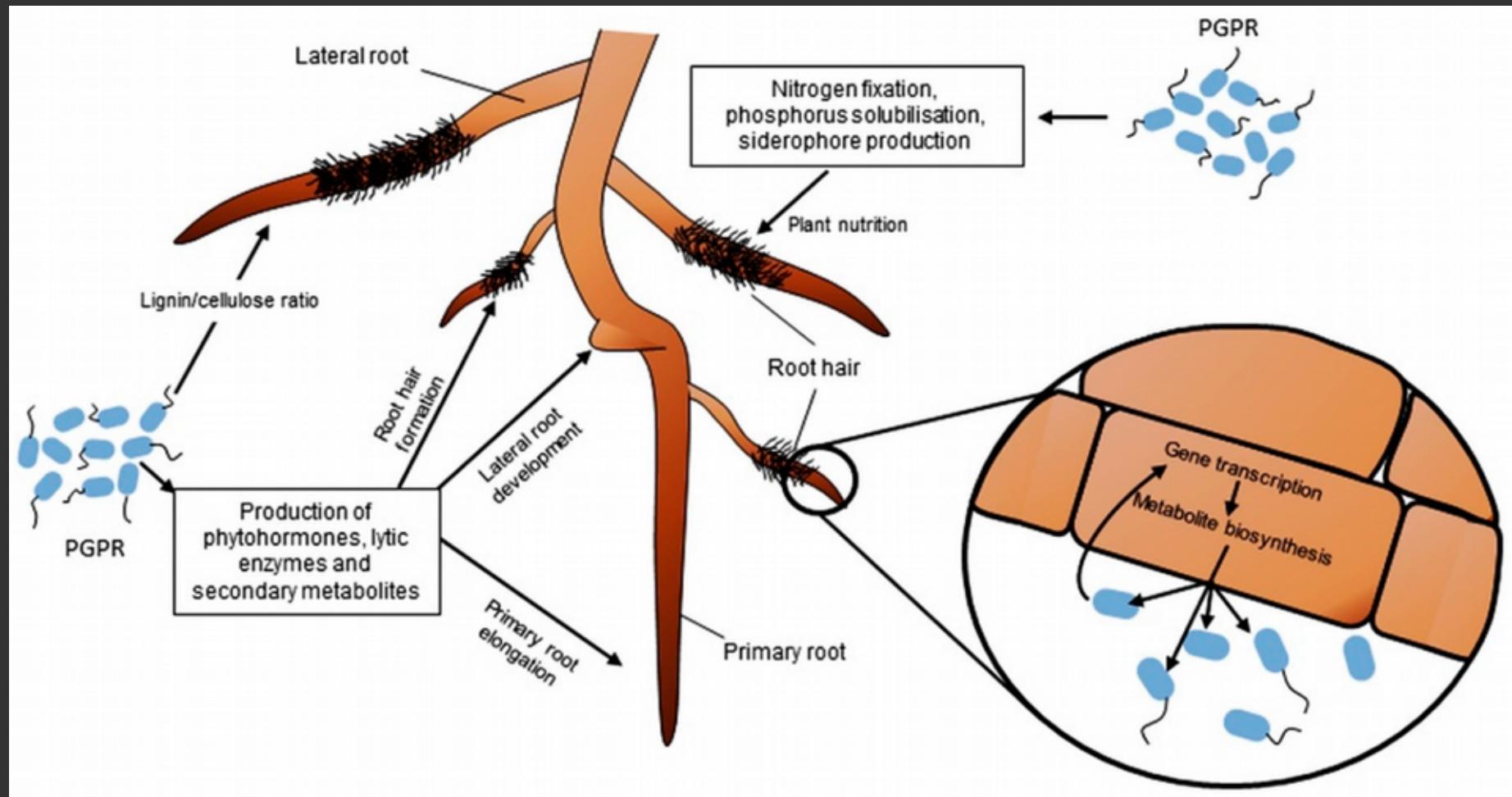
"Mycorrhizosphere" (the extended rhizosphere)



Mycorrhizosphere complexity

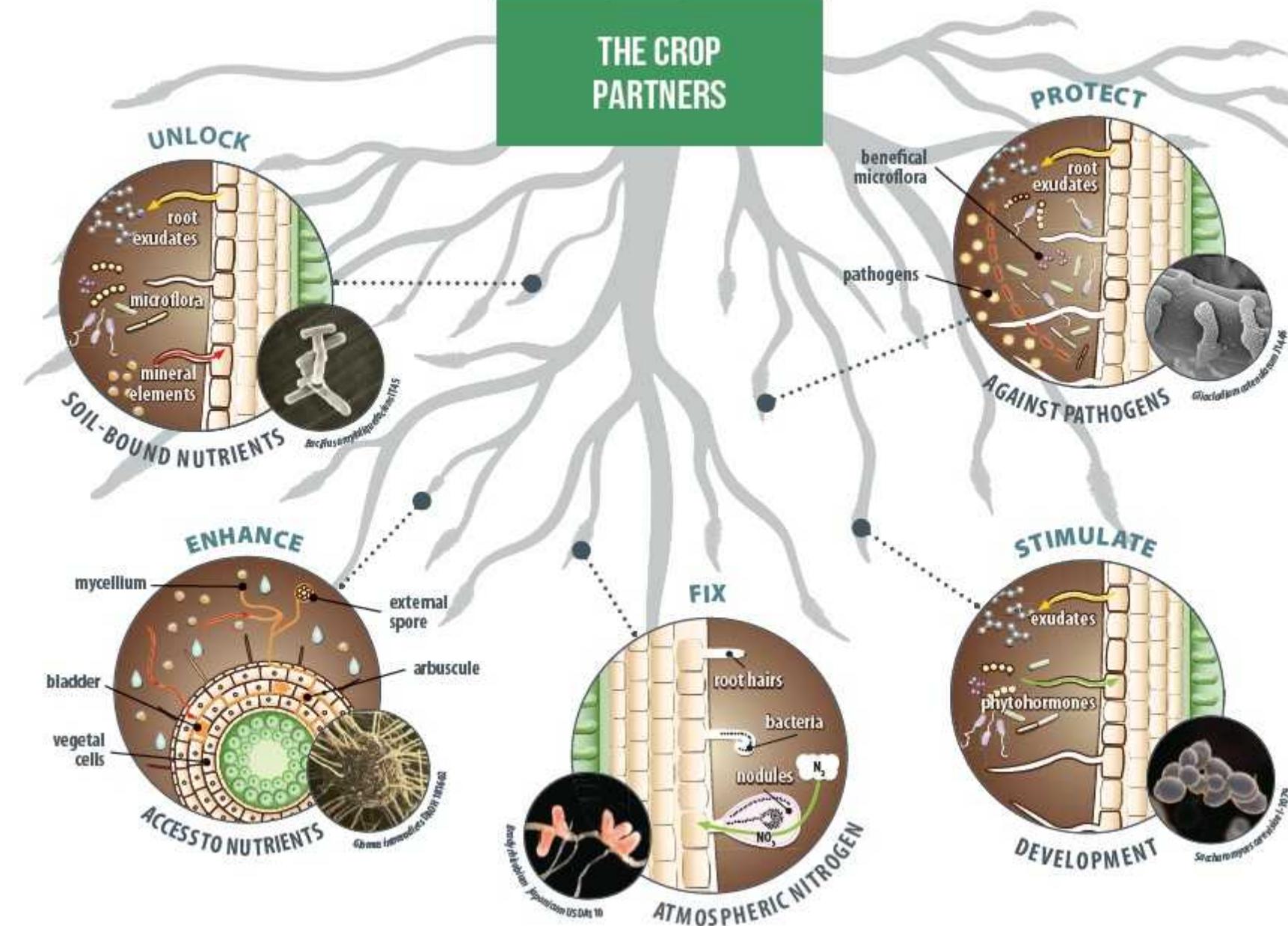


Plant-growth promoting rhizobacteria



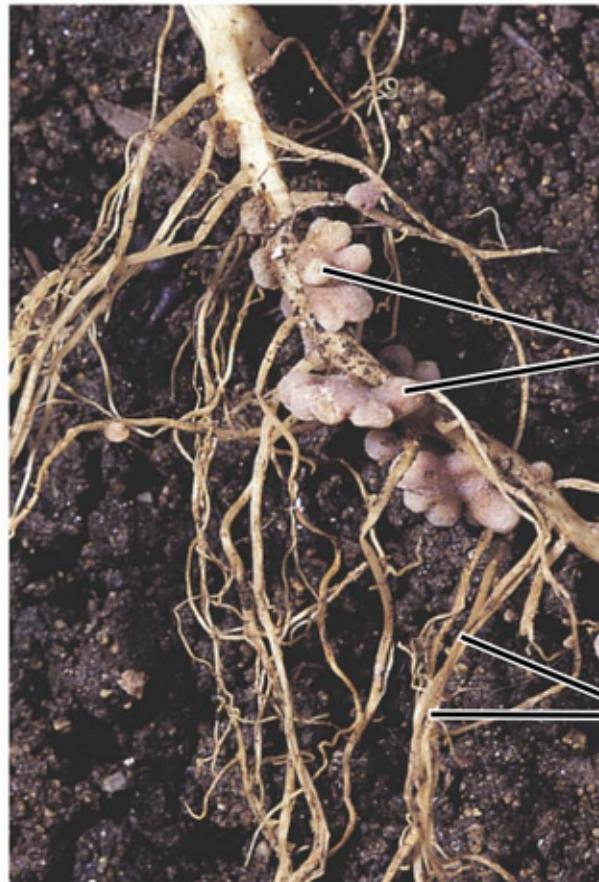
Some bacteria even make phytohormones

THE CROP PARTNERS

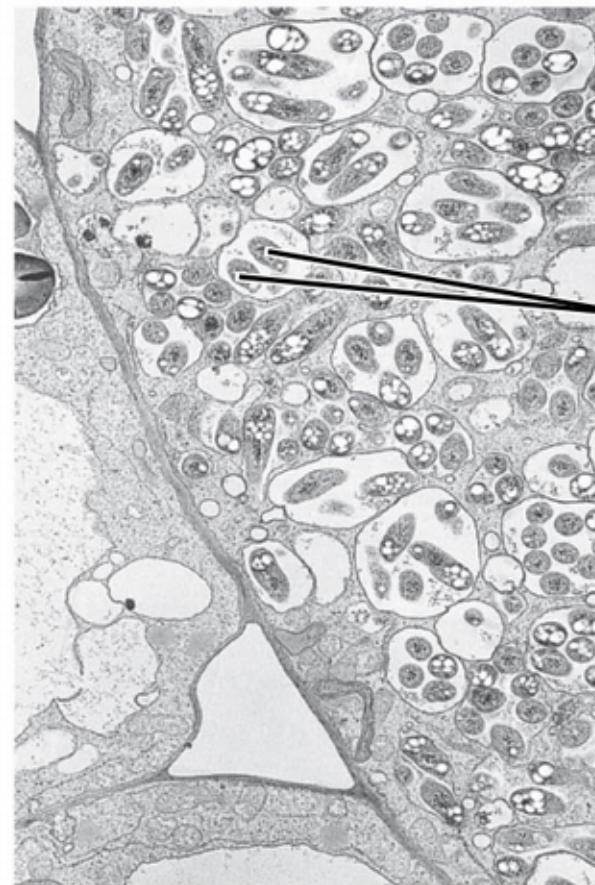


Rhizosphere bacteria

Root nodules on legume plants

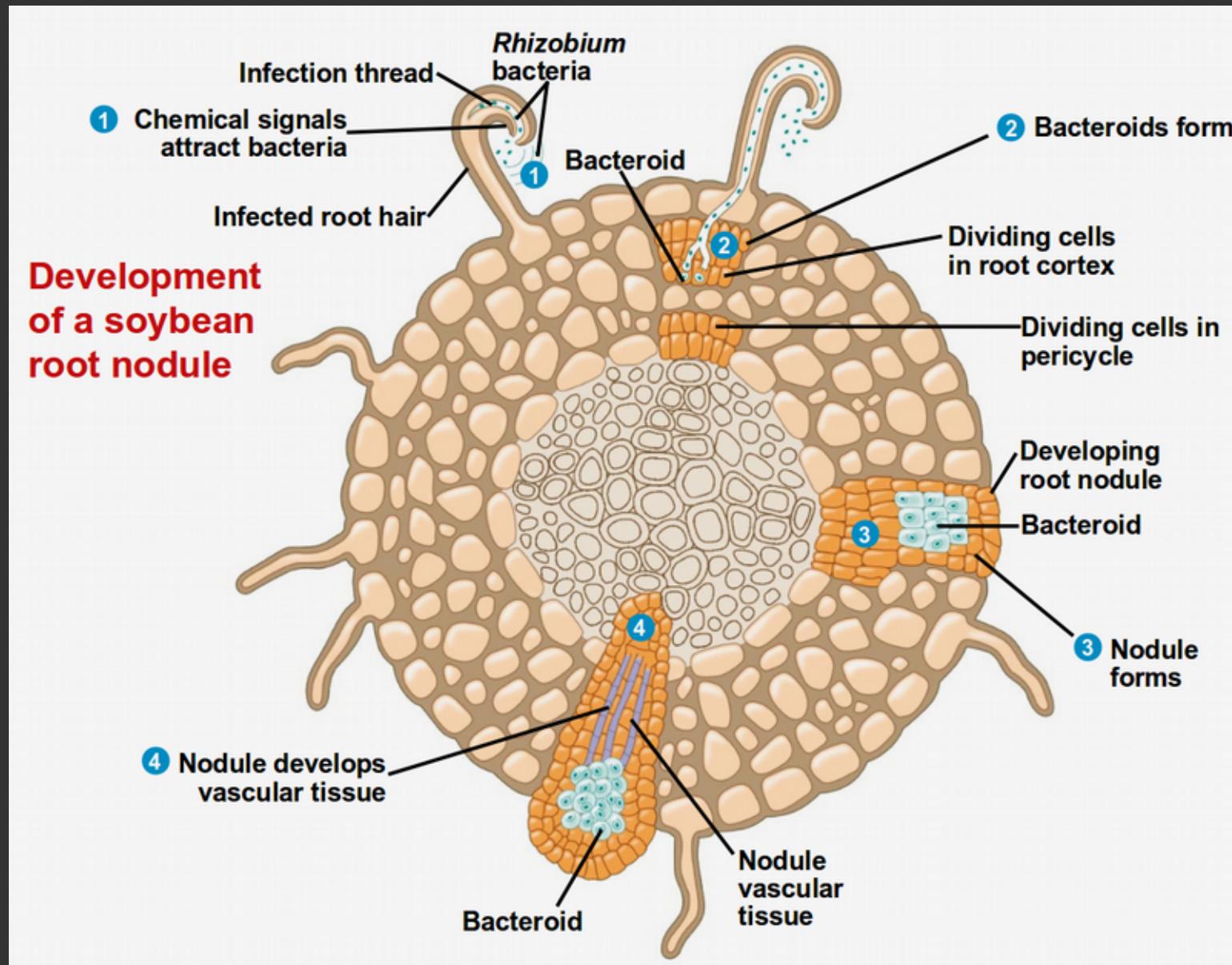


(a) Pea plant root



(b) Bacteroids in a soybean root nodule

Rhizobium infection of legume root

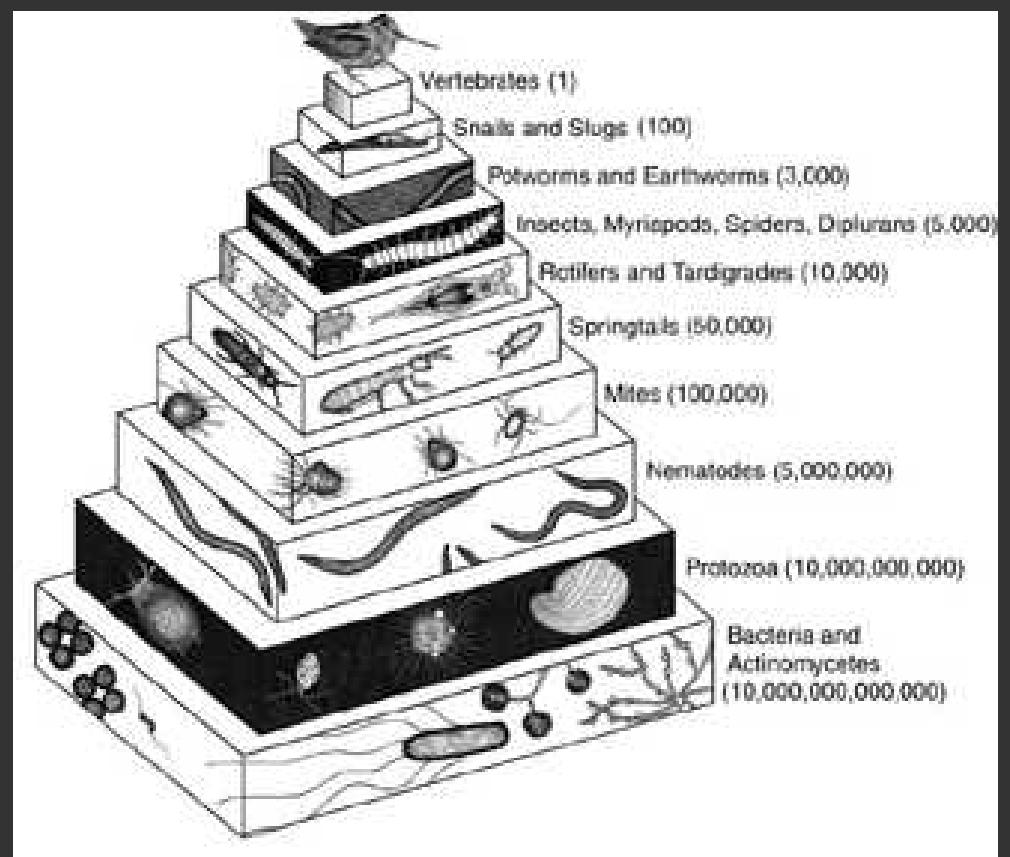


Soils are unbelievably complex

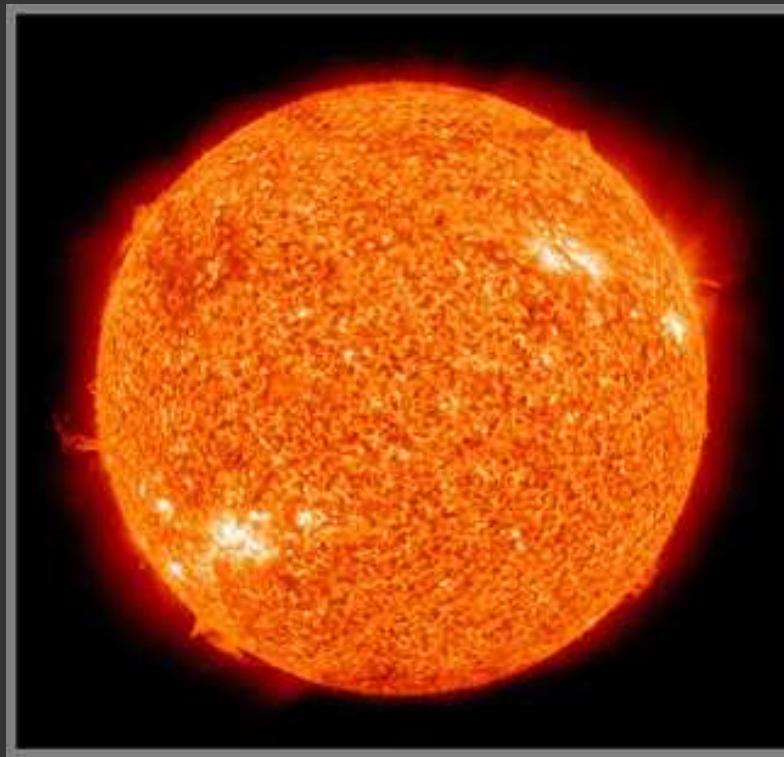
1 teaspoon of forest soil typically has:

- 40 MILES of fungal hyphae!
- 1 BILLION bacteria
- 100,000 protists
- 10,000 arthropods
- 100s of nematodes

10 m²



We know more about the chemistry
of this....than we do about this



Utah's only carnivorous plant



2003 © Peter M. Dziuk

Utah's only carnivorous plant



2003 © Peter M. Dziuk

Bladderwort



Fastest plant on earth



