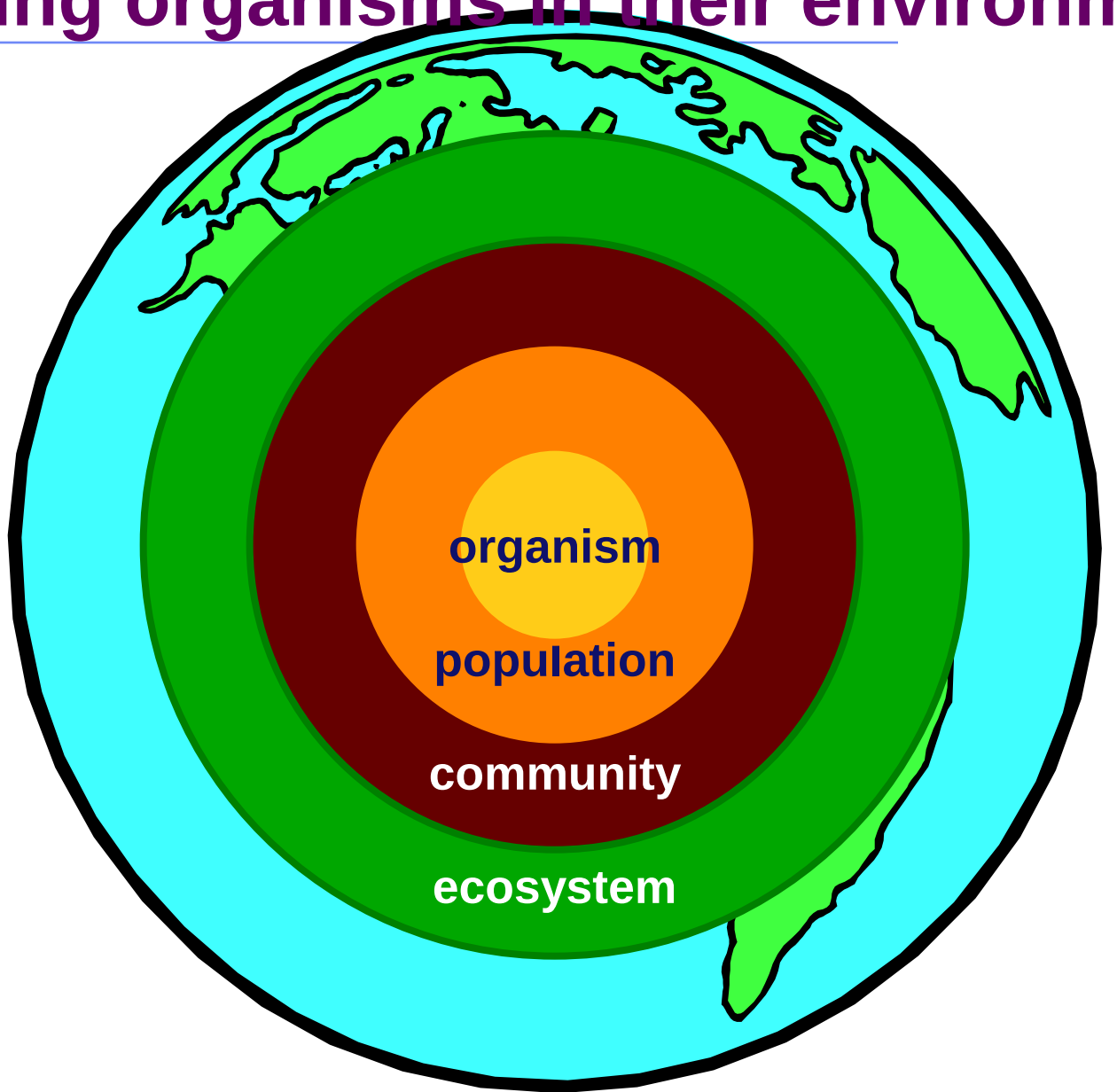

Ecosystems

Studying organisms in their environment



Essential questions

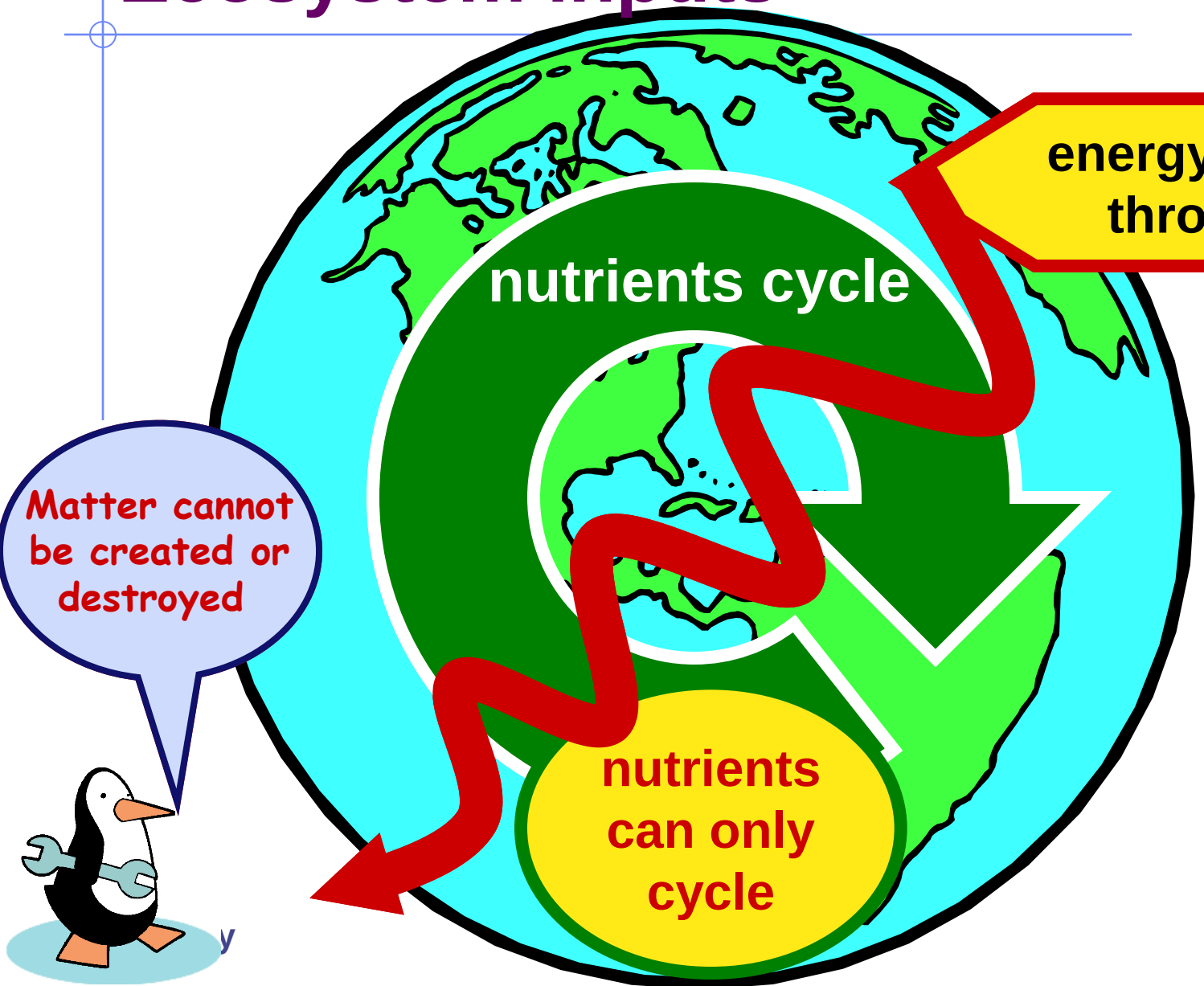
- What limits the production in ecosystems?
- How do nutrients move in the ecosystem?
- How does energy move through the ecosystem?

Ecosystem

- All the organisms in a community plus abiotic factors
  - ecosystems are transformers of energy & processors of matter
- Ecosystems are self-sustaining
  - what is needed?

- capture energy
- transfer energy
- cycle nutrients

Ecosystem inputs



inputs

- energy
- nutrients

Generalized Nutrient cycling

Decomposition connects all trophic levels

consumers

producers

decomposers

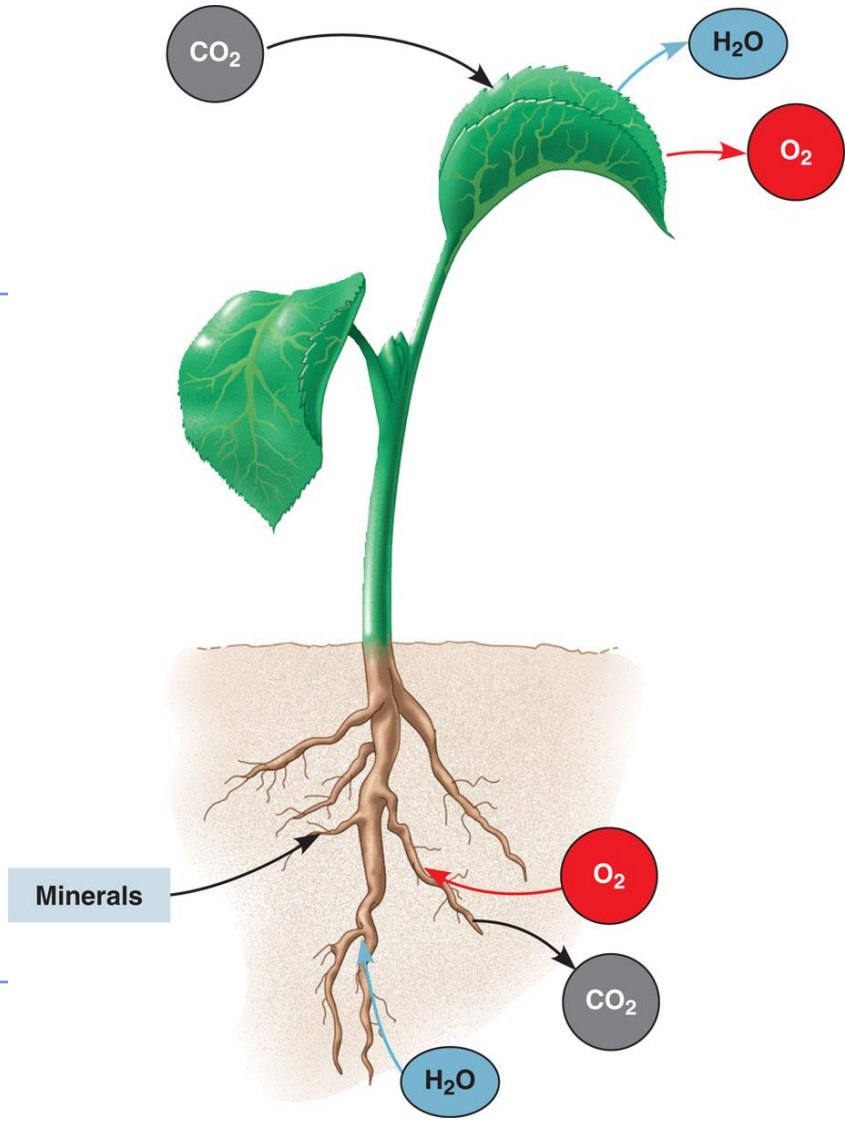
nutrients
ENTER FOOD CHAIN
= made available to producers

return to abiotic reservoir

abiotic reservoir

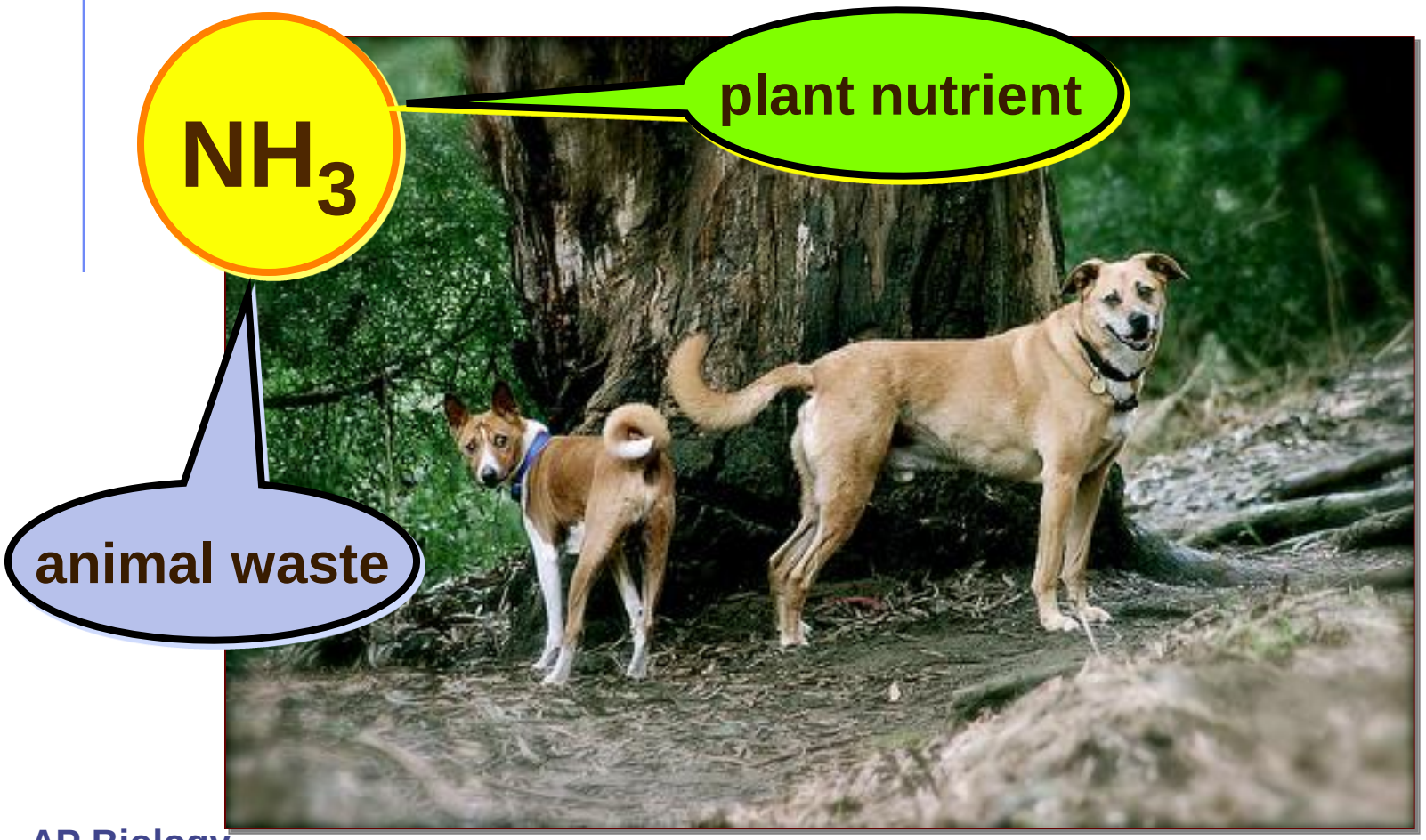
geologic processes

Plant Nutrition



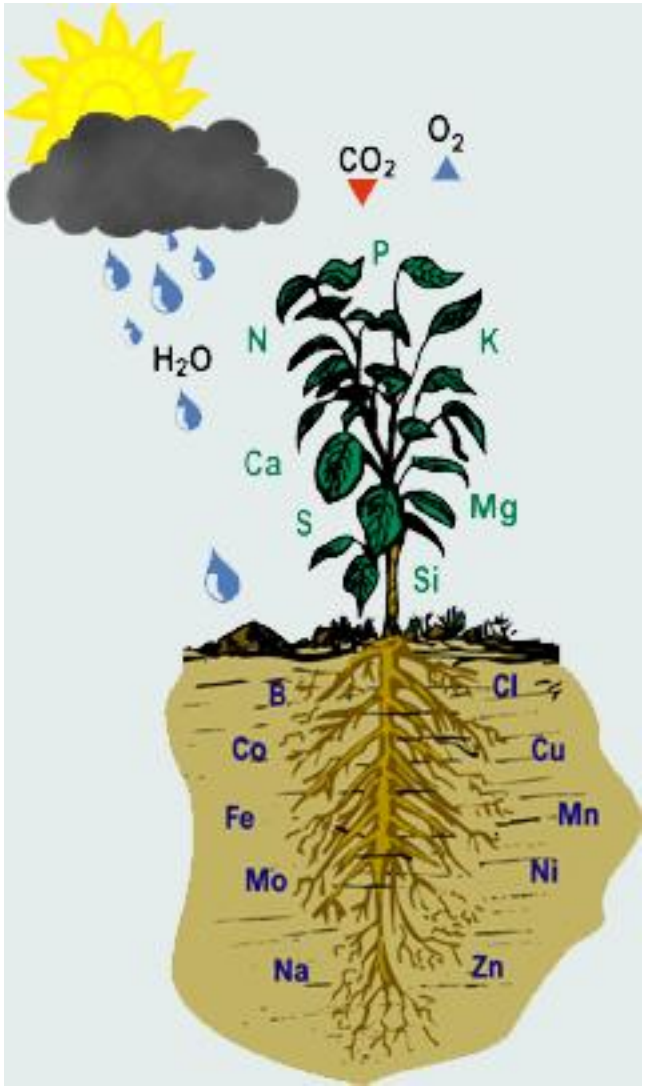
Physiological adaptation

Dogs pee on trees…Why don't trees pee on dogs?



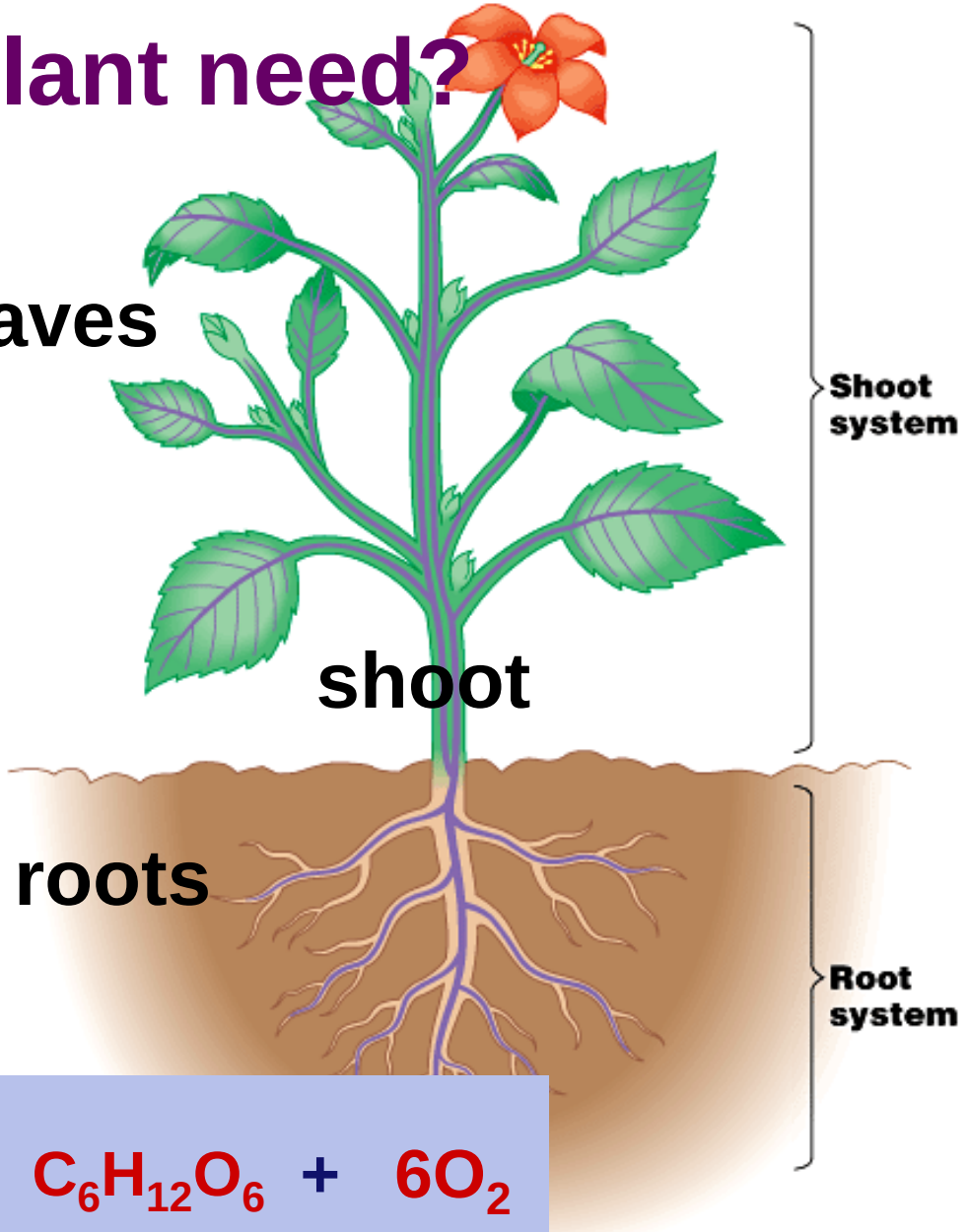
Nutritional needs

- **Autotrophic does not mean autonomous**
  - plants need…
    - **sun** as an energy source
    - **inorganic** compounds as raw materials
      - water (H_2O)
      - CO_2
      - minerals



So what does a plant need?

- Bring In
  - light
  - CO_2
  - H_2O
- Let Out
  - O_2
- Move Around
  - sugars



$$6CO_2 + 6H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

Macronutrients

- **Plants require these nutrients in relatively large amounts**
  - **C, O, H, N, P, K, Ca, Mg, S**

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_2O	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	$H_2PO_4^-$, HPO_4^{2-}	0.2%	Component of nucleic acids, phospholipids, ATP, several coenzymes
Sulfur	SO_4^{2-}	0.1%	Component of proteins, coenzymes

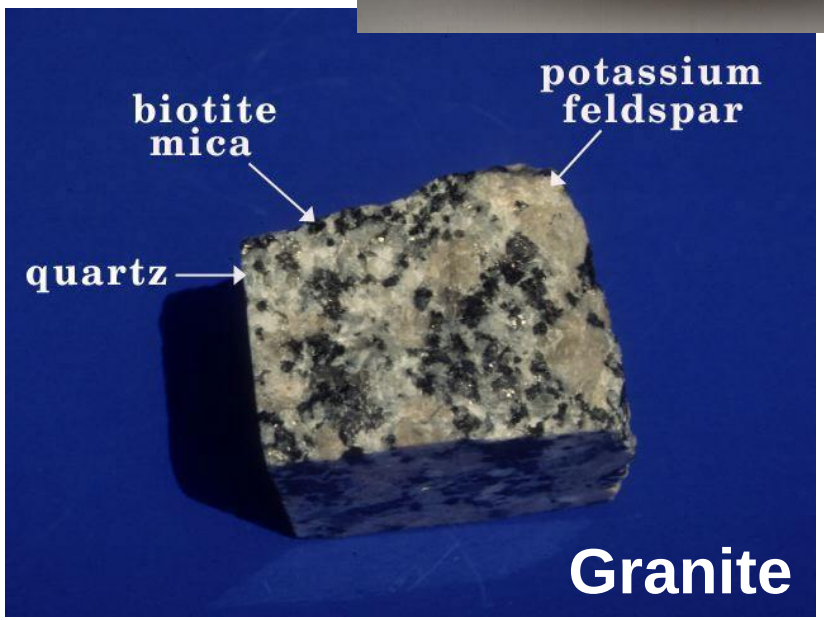
For what & from where?

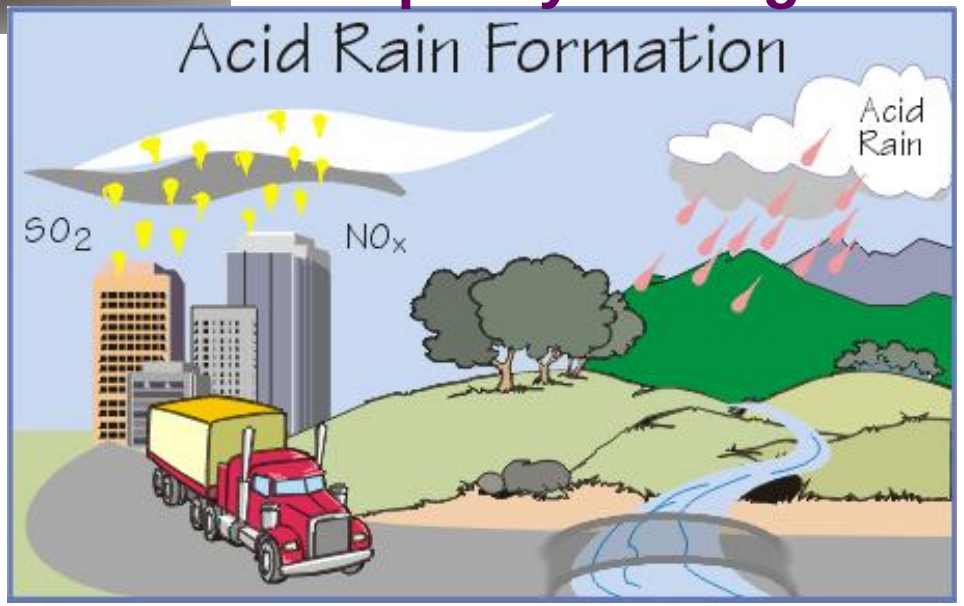
C	
O	
H	
N	
P	
K	
Ca	
Mg	
S	

Local soil issues

silica based soils
- low in P
- can be acid

Acid soils bind up mineral ions
↑pH by adding lime





Micronutrients

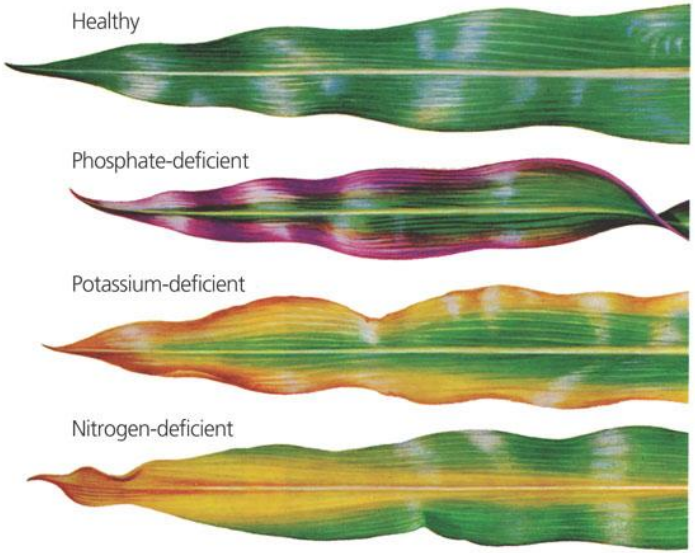
- **Plants require in very small amounts**
  - **Cl, Fe, Mn, Bo, Zi, Ni, Mb**
  - **primarily cofactors for enzyme function**

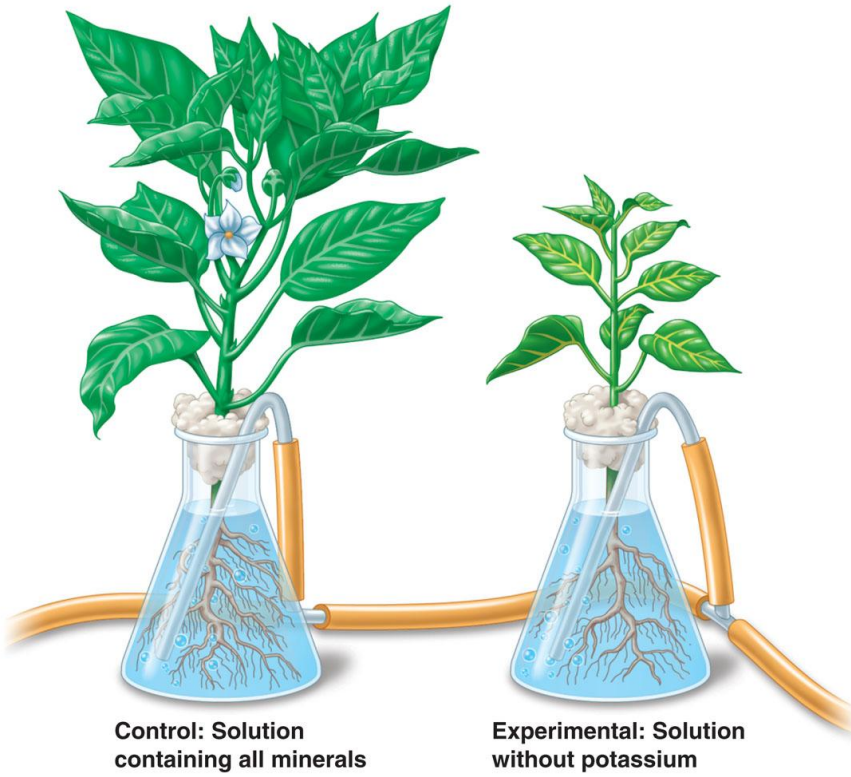
Table 37.1 Essential Elements in Plants

Element	Form Available to Plants	% Mass in Dry Tissue	Major Functions
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	$H_2BO_3^-$	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 that functions in nitrate reduction

Nutrient deficiencies

- Lack of essential nutrients
  - exhibit specific symptoms
    - dependent on function of nutrient
    - dependent on solubility of nutrient

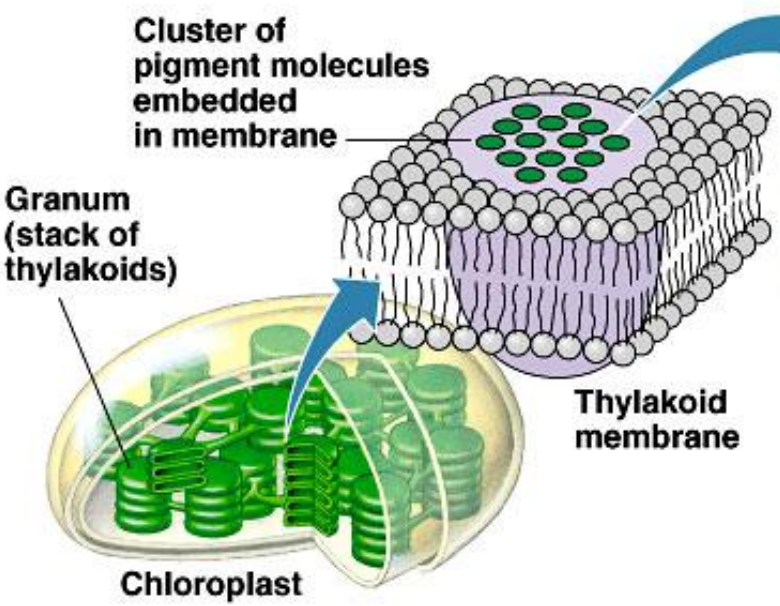


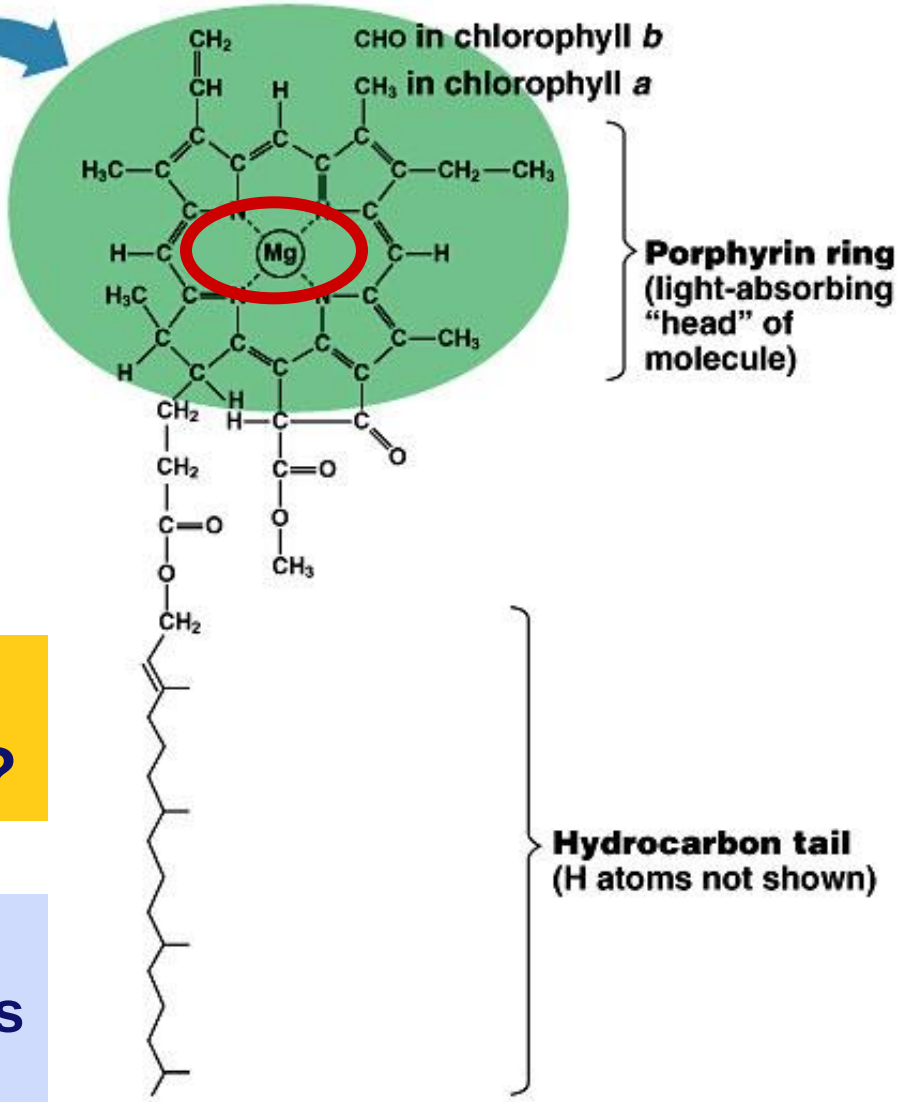


Magnesium deficiency

- **Symptoms**
  - chlorosis = yellowing of leaves
  - **Why?** What is magnesium's function?

Chlorophyll



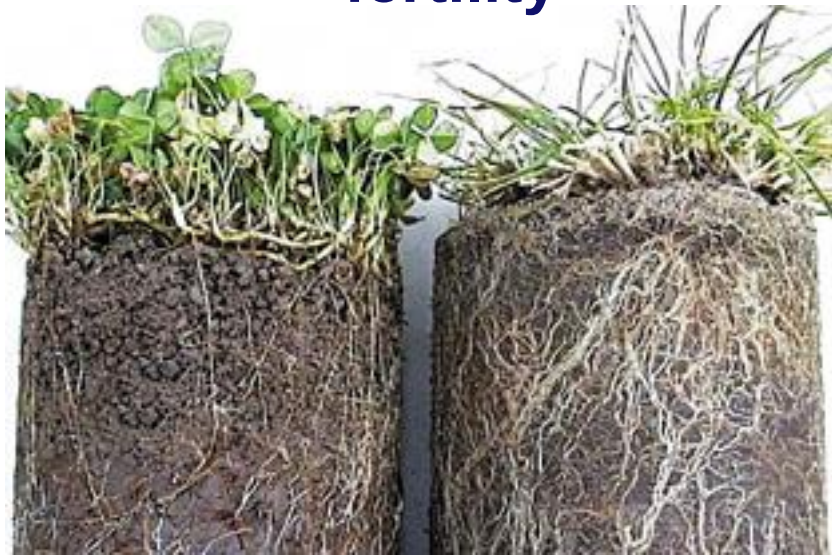


Why does magnesium deficiency cause chlorosis?

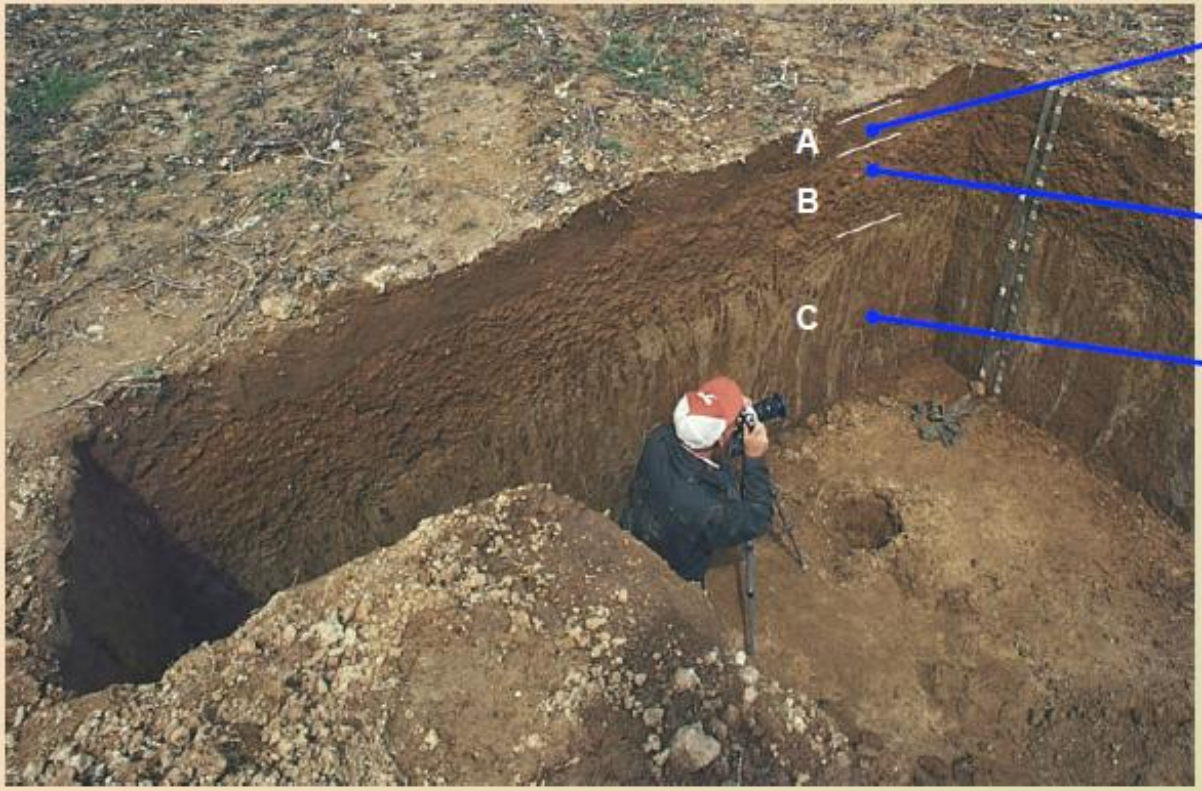
The chlorosis shows up in older leaves first, because plant moves Mg^+ to newer leaves. Why?

The role of soils

- **Plants are dependent on soil quality**
  - **texture / structure**
    - **relative amounts of various sizes of soil particles**
  - **composition**
    - **organic & inorganic chemical components**
    - **fertility**



Soil horizons



The A horizon is the topsoil, a mixture of broken-down rock of various textures, living organisms, and decaying organic matter.

The B horizon contains much less organic matter than the A horizon and is less weathered.

The C horizon, composed mainly of partially broken-down rock, serves as the "parent" material for the upper layers of soil.

Importance of organic matter

- Topsoil
  - most important to plant growth
  - rich in **organic matter**
    - **humus**
      - decomposing organic material
        - breakdown of dead organisms, feces, fallen leaves & other organic refuse by bacteria & fungi
      - improves soil texture
      - reservoir of minerals
  - organisms
    - 1 tsp. of topsoil has ~5 billion bacteria living with fungi, algae, protists, insects, earthworms, nematodes

Soil health as a global issue

Not taking care of soil health has far-reaching, damaging consequences

- 1920's Dust Bowl
- lack of soil conservation
  - growing the same crop year after year (wheat)
  - grazing by cattle
  - bare ground exposed to wind erosion in winter
  - drought

Soil health as a global issue

- **Soil conservation & sustainable agriculture**
  - maintaining healthy environment
  - sustainable production of food supply
  - economically viable farming industry

"A sustainable agriculture does not deplete soils or people."
– Wendell Berry

contour plowing

cover crops

crop rotation

Global issues

- soil fertility
- erosion
- irrigation
- forestry destruction













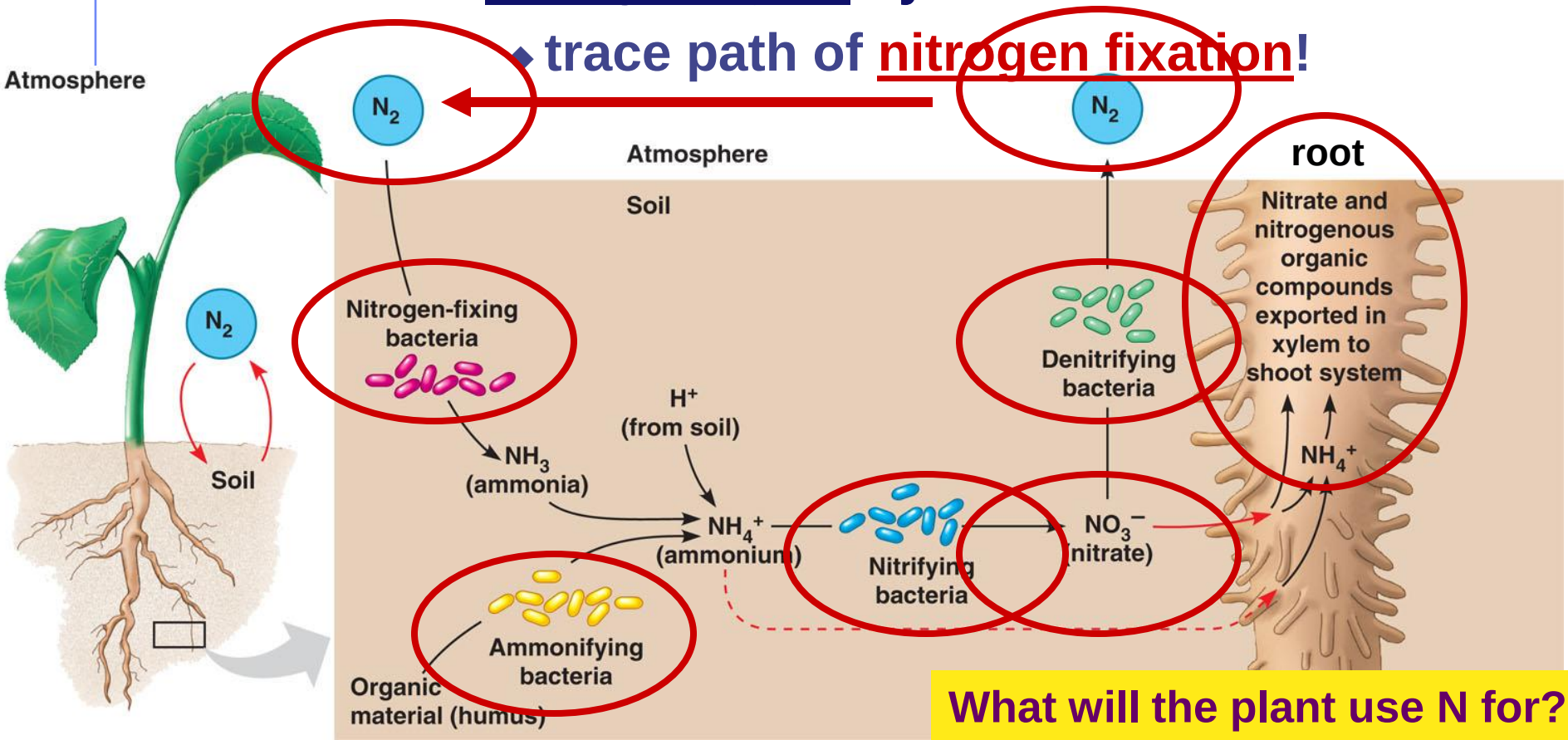


Fertilizers

- "Organic" fertilizers
  - manure, compost, fishmeal
- "Chemical" fertilizers
  - commercially manufactured
  - N-P-K (ex. 15-10-5)
    - 15% nitrogen
    - 10% phosphorus
    - 5% potassium

Nitrogen uptake

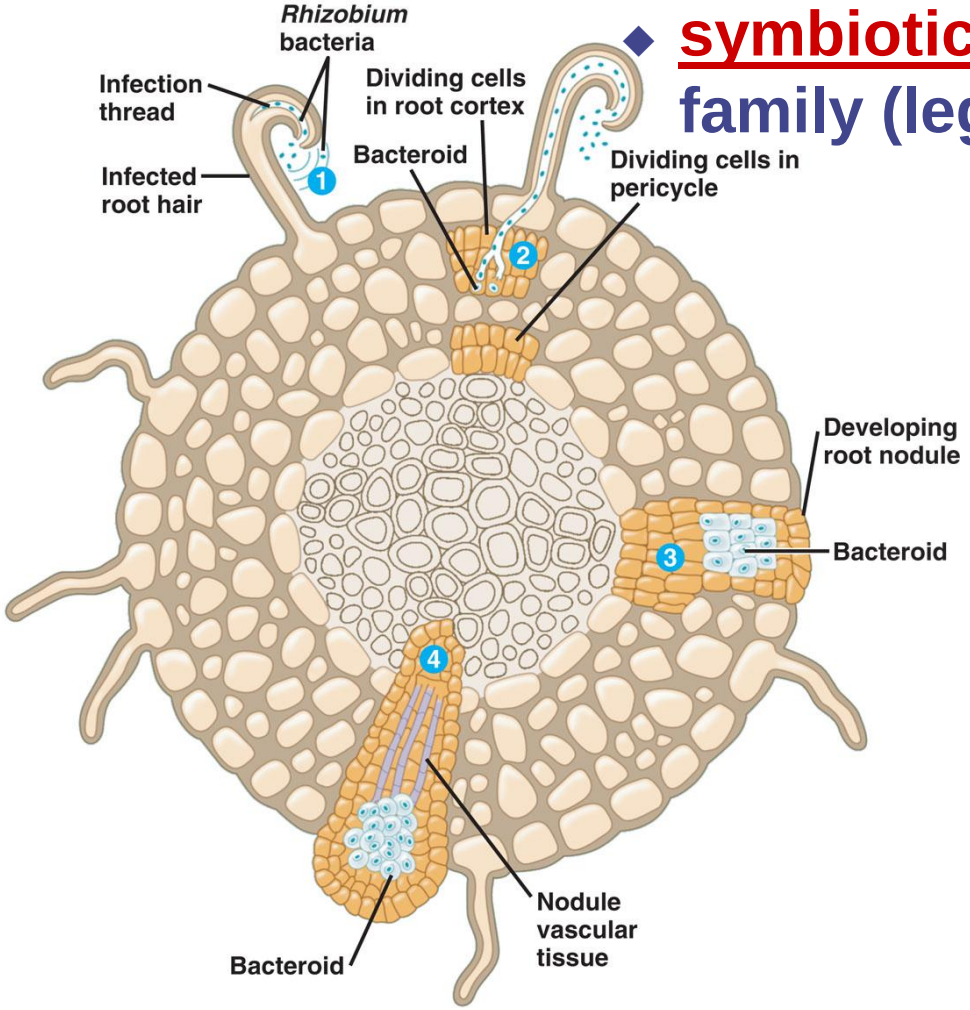
- **Nitrates**
  - plants can only take up nitrate (NO_3^-)
- **Nitrogen cycle** by bacteria
  - trace path of **nitrogen fixation**!

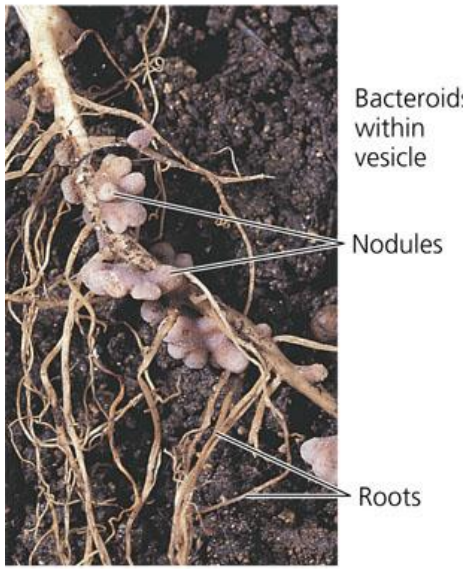


What will the plant use N for?

Soybean root nodules

- N fixation by ***Rhizobium*** **bacteria**
  - **symbiotic relationship with bean family (legumes)**



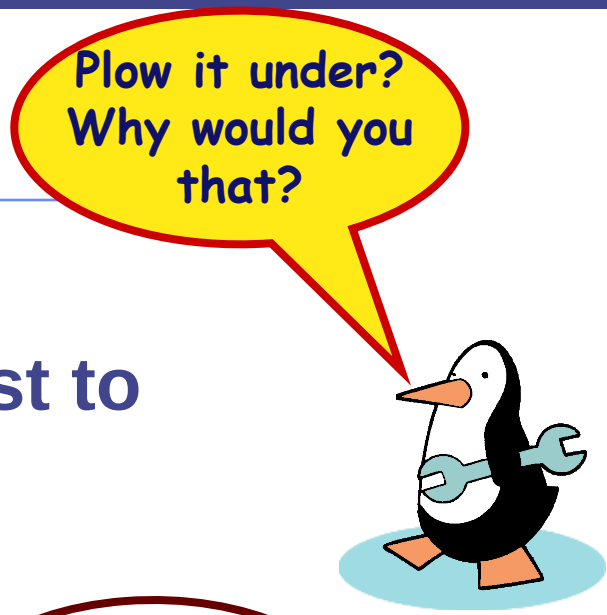


(a) **Pea plant root.** The bumps on this pea plant root are nodules containing *Rhizobium* bacteria. The bacteria fix nitrogen and obtain photosynthetic products supplied by the plant.

(b) **Bacteroids in a soybean root nodule.** In this TEM, a cell from a root nodule of soybean is filled with bacteroids in vesicles. The cells on the left are uninfected.

Increasing soil fertility

- Cover crops
  - growing a field of plants just to plow them under
    - usually a legume crop
    - taking care of soil's health
      - puts nitrogen back in soil



Some plant oddities…

Parasitic plants

- tap into host plant vascular system

Plants of peat bogs

- High acid environment
  - most minerals & nutrients bound up & are not available to plants
    - must find alternative sources of nutrients

Carnivorous plants

Venus fly trap

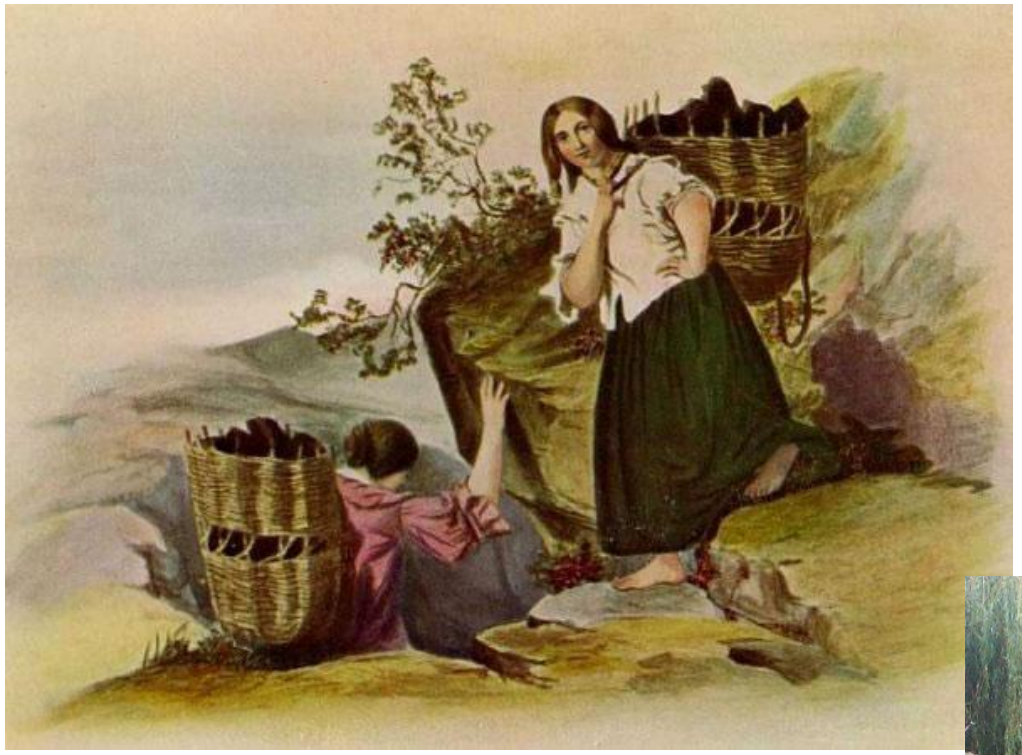
Pitcher plant

Sundew

Are they really carnivores?

Pitcher plant

Uses of peat

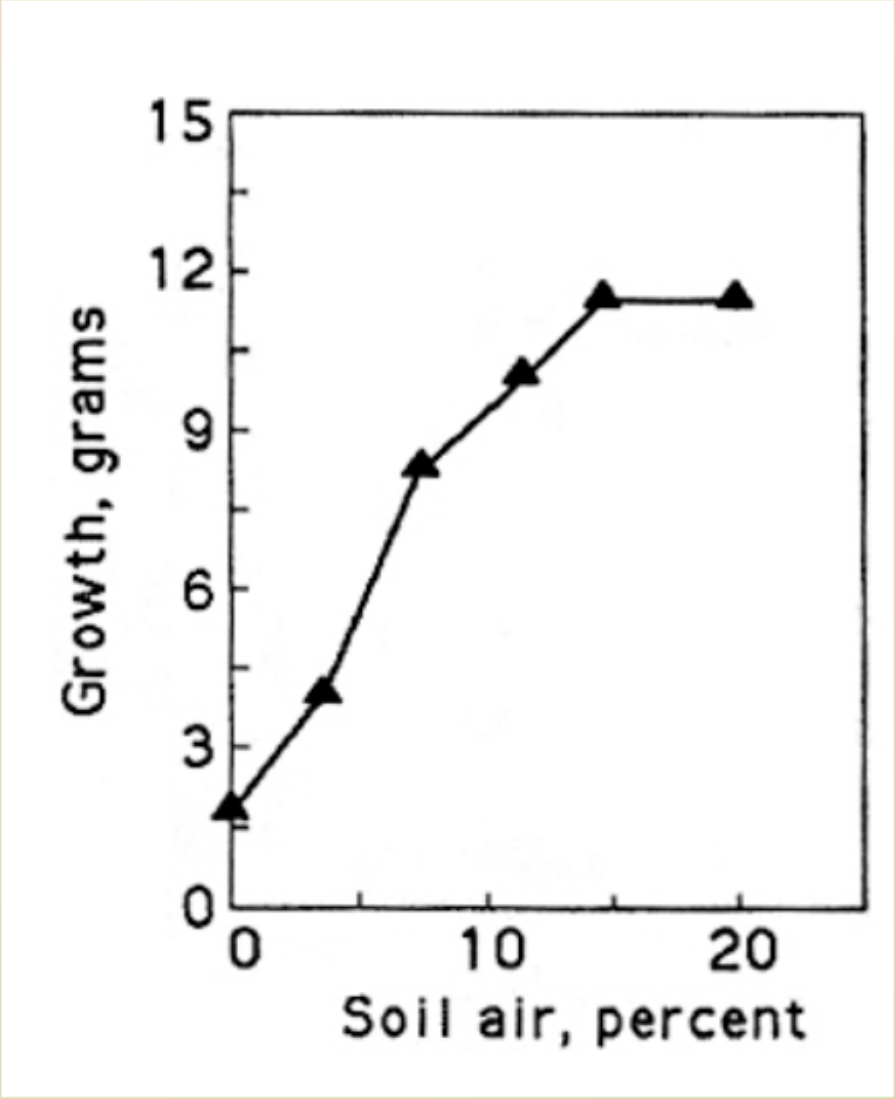


Review Questions

A. The inorganic compound that contributes most of the mass to a plant's organic matter is *

1. H_2O.
2. CO_2.
3. NO_3^2.
4. O_2.
5. $C_6H_{12}O_6$.

This figure shows the results of a study to determine the effect of soil air spaces on plant growth. Use these data to answer the following question.



C. The best explanation for the shape of this growth response curve is that

1. the plant requires air in the soil for photosynthesis.
2. the roots are able to absorb more nitrogen (N_2) in high levels of air.
3. most of the decrease in weight at low air levels is due to transpiration from the leaves.
4. increased soil air produces more root mass in the soil but does not affect the top stems and leaves.
5. the roots require oxygen for respiration and growth.

D. Carnivorous plants have evolved mechanisms that trap and digest small animals. The products of this digestion are used to supplement the plant's supply of

1. energy.
2. carbohydrates.
3. lipids and steroids.
4. minerals.
5. water.