PLANT NUTRITION

Chapter 37

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Plant Nutritional Requirements

- Plants require macronutrients/ micronutrients for metabolism
- Nutrient deficiencies cause abnormalities in structure/function

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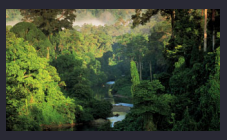
Mineral Nutrient Limitations

- Soil never contains sufficient quantities of all necessary plant nutrients
  - Leaching in moist to wet soils
  - Arid climates lack water in soils



- Herbivores obtain concentrated soil nutrients by eating plants

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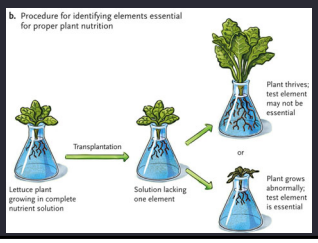
Hydroponics

- Hydroponic culture grows plants in solution
  - Remove one nutrient at a time, observe growth



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Macronutrients and Micronutrients

- **Macronutrients** essential in large quantities
  - C,H, O ~96% of dry mass, come from air, not considered minerals
  - Six Macronutrients
    - **Primary** = N, P, and K
    - **Secondary** = Ca, Mg, and S
- **Micronutrients** essential in trace quantities
  - May be enough in seeds for multiple generations (Ni)

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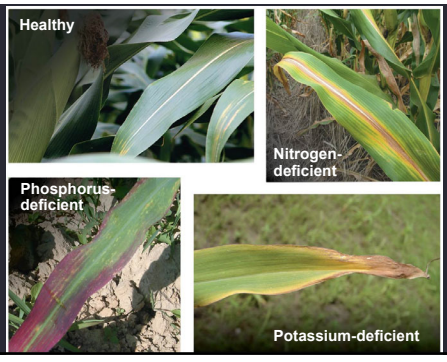

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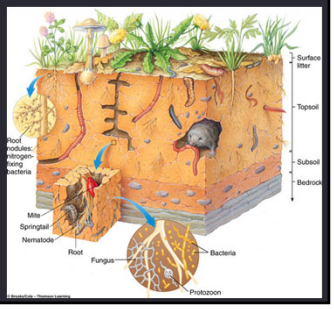
Soil

- Components/Size of particles determine properties
- Characteristics of soil affect root-soil interactions



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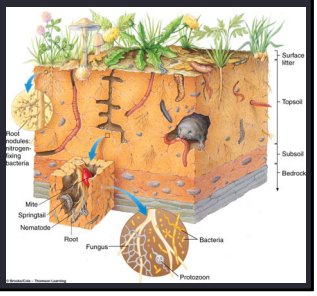
Soil

- Soil composed of:
  - Minerals
  - Ions
  - Humus (decomposing organics)
  - Water
  - Air
  - Organisms

Fertile soil
Faster organic matter turnover



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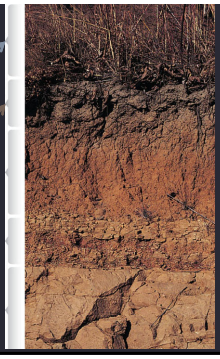
Soil Horizons

Soil development produces soil horizons

O horizon
Top
Organic-matter dominated

A horizon
Topsoil below O
Most roots



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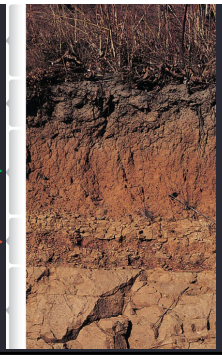
Soil Horizons

B horizon
Subsoil accumulates nutrients, woody roots

C horizon
Rock fragments, parent material



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WATER AVAILABILITY AND CATION EXCHANGE

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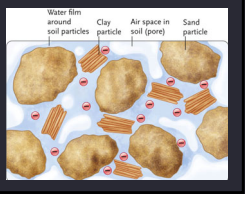
Water Availability

- Soil solution available for plant uptake after gravity drainage
  - Coats soil particles
  - Partially fills pore spaces
- Sandy soil looser, holds less water than clay soils
  - Humus increases water availability



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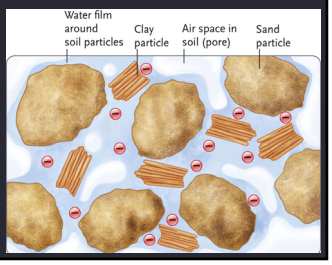
Water Availability

When water content of soil is low
- Water binds tightly to particles
- Roots must have lower Ψ than soil



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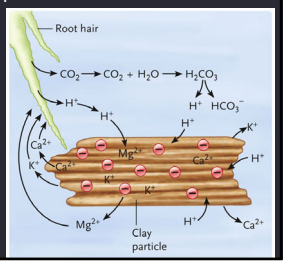
Mineral Availability

- Mineral cations adsorped to negative soil particules
  - Mg+
  - Ca2+
  - K+
- Cation exchange replaces mineral with H+ produced by:
  - Roots
  - Carbonic acid



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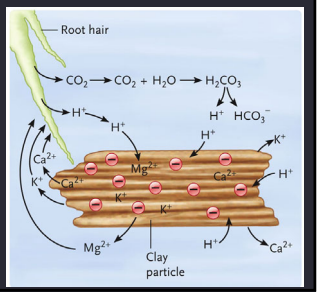
Mineral Availability

- Anions weakly bound to soil
  - NO^{3-}
  - SO_4^{2-}
  - PO^{4-}
- Move freely
- Therefore, will leach easily



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Root Systems

- Are adaptations to limited mineral nutrients
  - May be more than half of total plant mass
  - Roots grow as long as plant lives
- Roots have mechanisms to increase uptake
  - Root hairs
  - Membrane transporters

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Nutrient Movement

- Nutrients taken up actively, or passively via transpiration
  - Apoplastic or symplastic movement
  - Casparian strip
- Phloem moves nutrients from sources to sinks
  - Tissue/organ can change from source to sink (spring vs. fall foliage)

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CONVERSION OF NITROGEN

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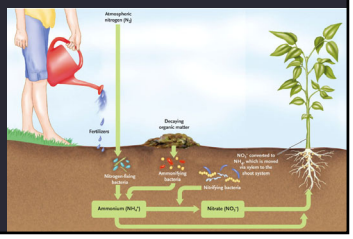
Nitrogen Limitations

- Nitrogen (N)
  - Abundant element in air, most limiting to plant
  - Nitrogen cycle provides soil nitrogen
- Nitrogen fixation incorporates atmospheric N_2 into plant-available compounds
  - Nitrogen-fixing bacteria
  - Lightning (small amounts)



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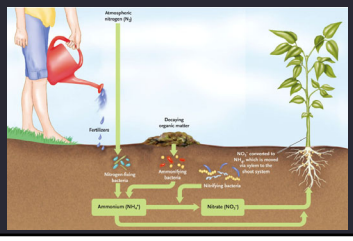
Nitrogen Cycling

- Bacterial ammonification breaks organic N compounds into NH4+
  - Plants take up NH4+, but prefer NO3-



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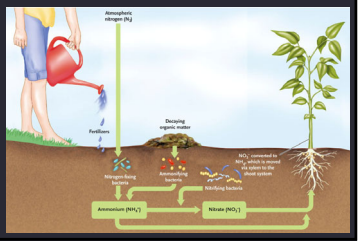
Nitrogen Cycling

- Bacterial nitrification converts NH_4^+ to NO_3^-
  - High rates of nitrification, except in acidic soils
- Plants convert NO_3^- to NH_4^+ to assimilate N into organic compounds



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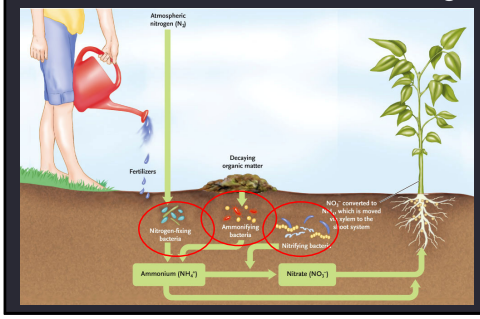
How Plants Obtain Nitrogen



Nitrogen fixation
- atmosphere

Ammonification
- Decaying organics

Nitrification
- Ammonium in soil

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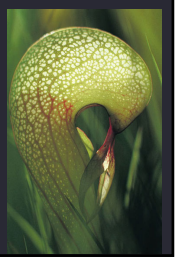
Other Nutrient Adaptations

- "Carnivorous" plants digest animals extracellularly
  - Most common in N-poor areas such as bogs
  - Grow faster with extra N from animals



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Other Nutrient Adaptations

- Parasitic plants :
  - Obtain some or all nutrients from other pl
  - (Some) conduct photosynthesis
  - Haustorial roots :
    - Tap into host vascular tissue

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