

Plant Function

Chs 38, 39 (parts), 40



KEB no office hour on
Monday 23 March

10 March 2009
ECOL 182R UofA
K. E. Bonine

Videos:
39.3, 34.3, 39.1, 34.1
Web Browser Open

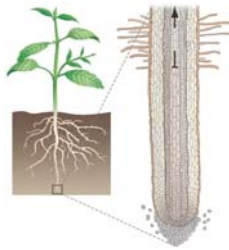
1

Video 39.3 Pollination of a night-blooming cactus by a bat



2

Plant Nutrition



182 Bonine
Spring 2009
10 March
(Freeman Ch38)

3

How do plants get
nutrients they need?

Usually from soil through
roots. A few interesting
exceptions...

<http://www.youtube.com/watch?v=ymlLpQNYI6g&feature=related>



4

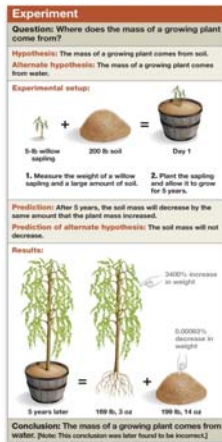
- In addition to carbon dioxide and water, plants require essential **nutrients**.
- Most nutrients are available as **ions** dissolved in soil water and are taken up by roots.
- Nutrient absorption occurs via specialized **proteins in plasma membranes of root cells**. Most plants also obtain _____ or _____ from _____ associated with their roots.

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Nutritional Requirements

- early 1600s, classic experiment by van Helmont
- mass of a growing plant comes from soil?
- mass of a growing plant comes from **water**?
- [Most of the mass of the tree actually comes from _____ in the atmosphere]

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Which Nutrients Are Essential?

- An **essential nutrient**: required for both **normal growth and reproduction** and for a specific structure or metabolic function.
- There are **17 essential** nutrients for most vascular plants.

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Which Nutrients Are Essential?

- Classified based on whether from **water &/or carbon dioxide** versus from **soil**.
- Essential nutrients available from H_2O or CO_2 are **They make up 96% of the plant.**
- Soil elements can be divided into **macronutrients** and **micronutrients**.

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- **Macronutrients** are the **building blocks** of nucleic acids, proteins, carbohydrates, phospholipids, and other key molecules required in relatively **large quantities**. They are
 - nitrogen (N)
 - potassium (K)
 - calcium (Ca)
 - magnesium (Mg)
 - phosphorus (P)
 - sulfur (S).

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Which Nutrients Are Essential?

- **Limiting nutrients** are macronutrients that commonly act as limits on plant growth. **nitrogen and phosphorus** are often limiting nutrients.

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Which Nutrients Are Essential?

- **Micronutrients** are required in very **small quantities**. Rather than acting as components of macromolecules, they usually function as **cofactors** for specific enzymes. Examples include:
 - **iron, zinc, boron, copper, and nickel.**

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nutritional deficiencies

- **Hydroponic growth** takes place in liquid cultures, without soil, so the availability of nutrients can be precisely **controlled**.

Google [Advanced Search](#) [Preferences](#)

Web Results 1 - 10

[Grow Big Fat BadAss Buds](#)
www.GrowersUnderground.com The Size Of Your Arms New System Does It For You

[Hydroponic Tomatoes - The Grow Store](#)
Item: **Hydroponic Tomatoes** Home-grown tomatoes ... large, red-ripe, deliciously aromatic and full of ... **Humboldt** Nutrients Hydro for Hunger. Sponsored By www.thegrowstore.com/detail.asp?itemnumber=35 - 20k - [Cached](#) - [Similar pages](#)

[Books - Hydroponics - Organic Gardening - Co2, Grow Lights](#)
2 part Amino Acid Chelated Nutrients **Humboldt** Nutrients ... Price: \$19.95. **Hydroponic Tomatoes** For The Home Gardener Price: \$14.95 ... www.thegrowlight.com/books-hydroponics-organic-gardening-grow-lights/ - 116k - [Cached](#) - [Similar pages](#)

[Weed Chat Today | Blogthing | North Coast Journal | Humboldt ...](#)
Sligh's blog, "**Humboldt** Grow," details the nuts and bolts of marijuana growing ... My Grandma wants to know when the roundtable on **hydroponic tomatoes** and ... www.northcoastjournal.com/blogthing/2009/02/12/weed-chat-today/ - 20k - [Cached](#) - [Similar pages](#)

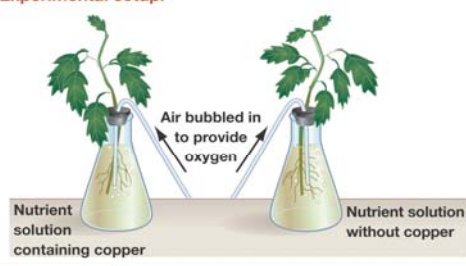
[Hydroponic Tomatoes ...](#)
This book makes growing fantastic **hydroponic tomatoes** much easier ... How-To **Hydroponics** **Humboldt** Nutrients Micro 32 oz. - 15 gal. ... briteideas**hydroponics**.com/eshop/product.php?productid=1069&cat=0&page=1&jsn=38k - [Cached](#) - [Similar pages](#)

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Experiment

Experimental setup:

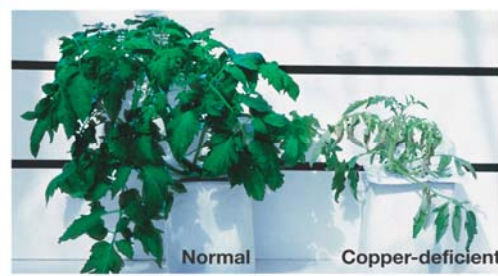


Prediction: The copper-deficient plant will grow less than the normal plant.
Prediction of null hypothesis: Both plants will grow the same.

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Experiment

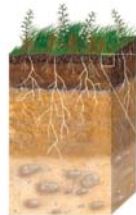
Results:



Conclusion: Copper deficiency leads to poor growth. All tissues appear to be affected adversely.

Soil

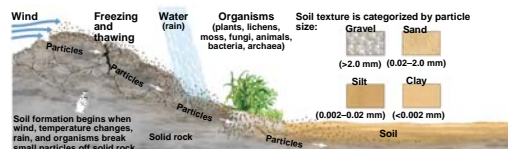
- **Weathering**—the forces applied by rain, running water, and wind—begins the process of building soil from solid rock.
- Particles derived from rocks are the first ingredient in soil. As organisms occupy the substrate, they add dead cells and tissues. This organic matter is called



- **Organic + Inorganic = Mature Soil**

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Soil Formation Begins with Erosion of Rock



Succession...

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What Factors Affect Nutrient Availability?

- Cations tend to bind to soil particles, while anions stay in solution.
- The loss of nutrients via washing is called **leaching**.

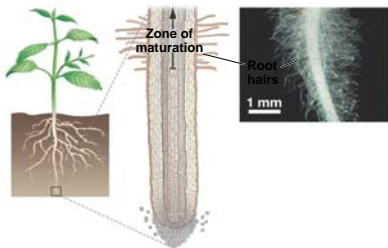
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What Factors Affect Nutrient Availability?

- Soil pH can also influence the availability of essential elements. Soils can be **acidic** (low pH) or **alkaline** (high pH).

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Root Hairs Increase the Surface Area Available for Nutrient Absorption



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Mechanisms of Nutrient Uptake

- Plant cell walls are permeable to ions, small molecules, and even large molecules.
- The plasma membrane, however, is **highly selective**. Membrane proteins allow only specific ions to cross the plasma membrane.



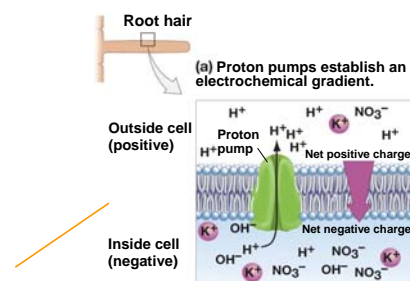
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Establishing and Using a Proton Gradient

- Root-hair cells have **proton pumps** (H^+ -ATPases) in their plasma membranes that move nutrients into the cell against a strong concentration gradient.

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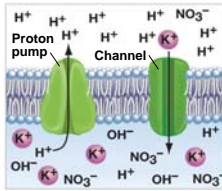
Ions Enter Roots along Electrochemical Gradients Created by



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Cations Enter Roots via _____

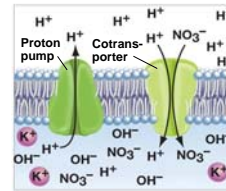
(b) Cations enter root hairs via channels.



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Anions Enter Roots via _____

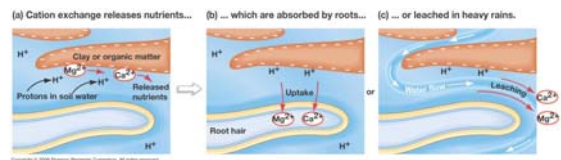
(c) Anions enter root hairs via cotransporters.



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Cation vs Anion Nutrients

- **Anions** easier to get than cations
 - But anions can leach out of sandy soils
 - Anions better retained in clay soils
- **Cations** often bound to organic or inorganic soil particles
 - for Mg⁺ or K⁺ or Ca⁺ etc.
 - Plants facilitate by pumping H⁺ out of root hairs



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 for Mg⁺ or K⁺ or Ca⁺ etc.

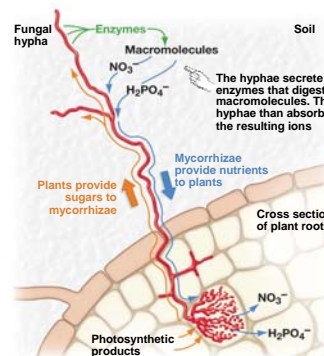
Plants facilitate by pumping H⁺ out of root hairs

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Nutrient Transfer via Mycorrhizal Fungi

- Vast majority of plants take up nutrients through their root hairs
- But, most **need more nitrogen and phosphorus**
- Help from fungi that live in close association with their roots.
- These fungi are called _____

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mycorrhizae provide _____ and/or _____

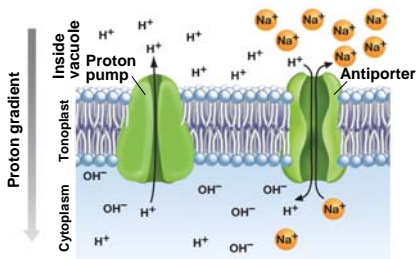
_____ to the plants in exchange for **sugar**.

 mutualism

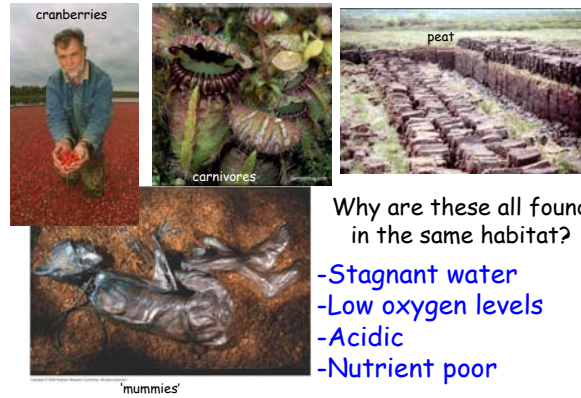
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Not all soil ions are "good" for the plant
 In Salt-Tolerant Plants, an _____
 Concentrates Sodium in Vacuoles

(a) In the tonoplast, antiporters send H⁺ out and Na⁺ in.



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Why are these all found in the same habitat?

- Stagnant water
- Low oxygen levels
- Acidic
- Nutrient poor

BOGS

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Some species of plant have specialized methods of obtaining nutrients, including associations with **nitrogen-fixing bacteria**, **parasitism**, and **carnivory**.

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Nitrogen Fixation

- Plants and other eukaryotes cannot use N₂ from the atmosphere.
- However, some _____ are able to absorb N₂ from the atmosphere and convert it to ammonia, nitrates, and nitrites in a process called **nitrogen** _____.

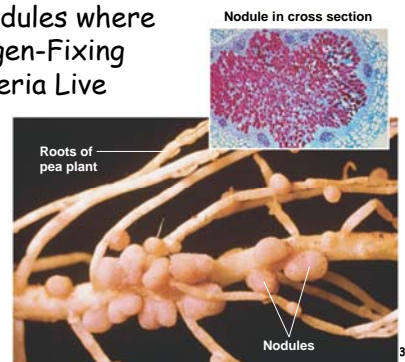
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Nitrogen Fixation

- Such bacteria often **take up residence** inside plant root cells.
- For example, members of the bacterial genus *Rhizobium* associate with plants in the pea family (**legumes**).
- Rhizobia** (*Rhizobium* species and close relatives) are found in _____ on the roots of legumes and provide the plant with
- ammonia in return for sugar and protection**

35

In Some Plants, Roots Form Nodules where Nitrogen-Fixing Bacteria Live



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Nutritional Adaptations of Plants

- **Most** plants use proton pumps as a mechanism for importing **nutrients** from the soil and/or acquire nutrients from symbiotes.
- In addition, **99%** of plants make their own **sugars**.
- Some plants don't follow these rules, some appear to live on:
 - 1) _____, some 2) _____ others, some catch 3) _____.

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Epiphytic Plants

- **Epiphytes** are plants that are adapted to grow in the _____ They often grow on leaves or branches of trees.
- They absorb most of the water and nutrients they need from **rainwater, dust, and particles** that collect in their tissues or in the crevices of bark.

(b) Water-holding "tanks" formed by leaves of an epiphytic bromeliad



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Epiphytes Are Adapted to Grow in the Absence of Soil

(a) Epiphytes grow on trees (e.g., Bromeliads).



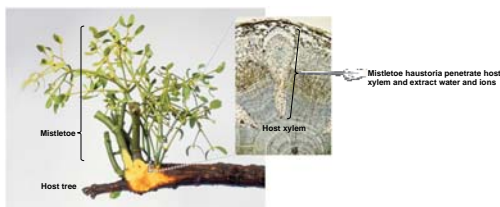
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Parasitic Plants

- **Most** parasitic plants make their own sugars through _____ and **tap into the vascular tissue of their hosts for water and essential nutrients.**
- **Some** plant parasites are **nonphotosynthetic** and obtain all their nutrition from the host.
- There are at least 3000 species of parasitic plants

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Some Plant Parasites Tap into the Xylem Tissue of Their Hosts



Mistletoe

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Carnivorous Plants

- **Carnivorous** plants use modified leaves to **trap insects and other animals**, kill them, and **absorb the prey's nutrients**.
- Carnivorous species make their own carbohydrates via photosynthesis but use carnivory to **supplement the** nutrients available in the environment, which is often lacking.

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Sundews Have Modified Leaves with a Sticky Surface That Catches Insects



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