Plant Function

Chs 38, 39 (parts), 40

KEB no office hour on
Monday 23 March

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

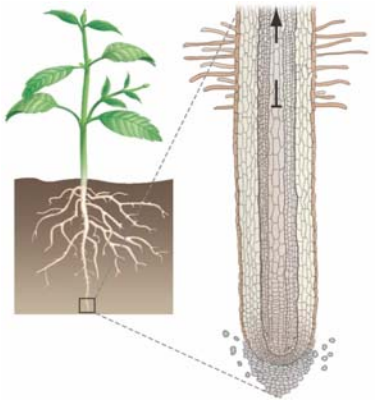
Videos:
39.3, 34.3, 39.1, 34.1
Web Browser Open

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=ymnLpQNyI6g&feature=related

4

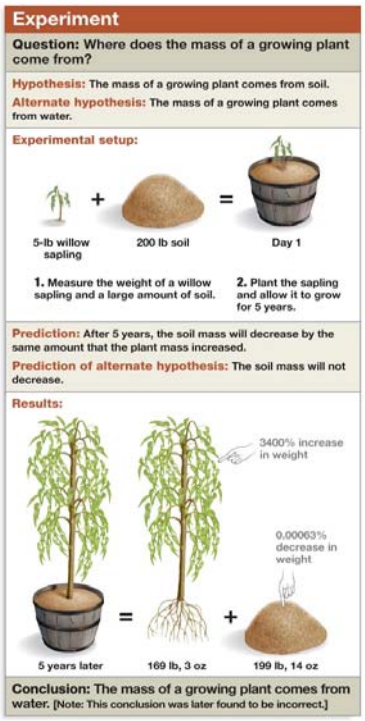
- In addition to carbon dioxide and water, plants require essential nutrients.
- Most nutrients are available as ions dissolved in soil water and are taken up by roots.
- Nutrient absorption occurs via specialized proteins in plasma membranes of root cells. Most plants also obtain _____ or _____ from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

5

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]

6



7

Which Nutrients Are Essential?

- An _____ **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.

8

Which Nutrients Are Essential?

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

9

- **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).

10

Which Nutrients Are Essential?

- **Limiting nutrients** are macronutrients that commonly act as limits on plant growth.

  and are often limiting nutrients.

11

Which Nutrients Are Essential?

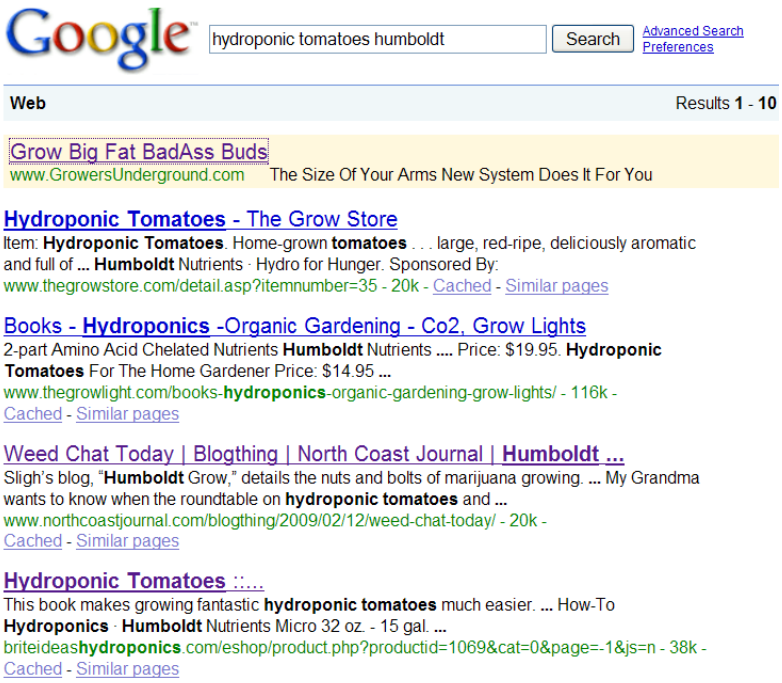
- **Micronutrients** are required in very small quantities. Rather than acting as components of macromolecules, they usually function as cofactors for specific enzymes. Examples include:
- iron, zinc, boron, copper, and nickel.

12

nutritional deficiencies

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

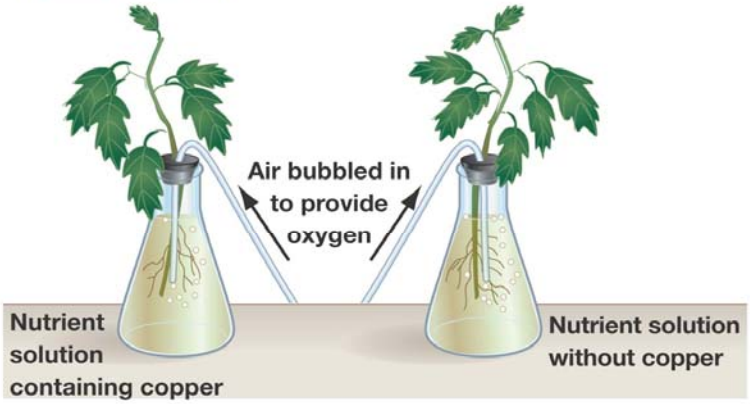
13



14

Experiment

Experimental setup:



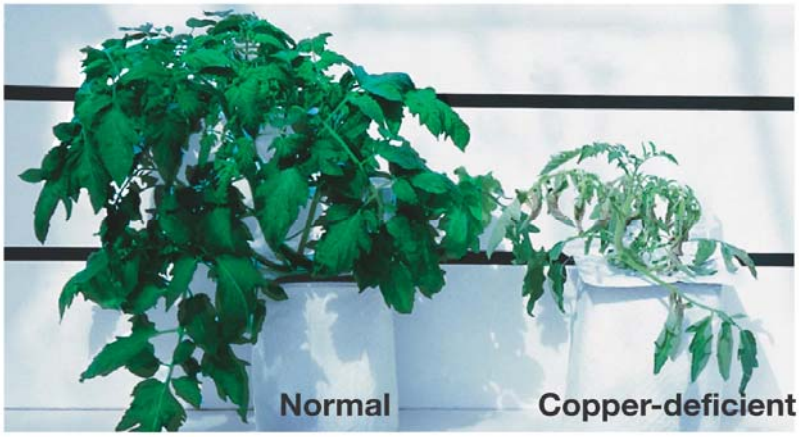
Prediction: The copper-deficient plant will grow less than the normal plant.

Prediction of null hypothesis: Both plants will grow the same.

15

Experiment

Results:



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

Soil

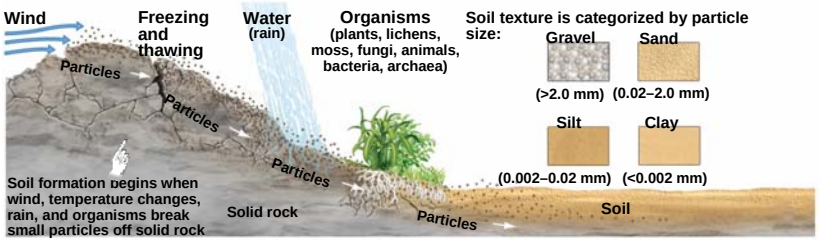
- **Weathering**—the forces applied by rain, running water, and wind—begins the process of building soil from solid rock.

- 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

17

Soil Formation Begins with Erosion of Rock



Succession…

18

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**.

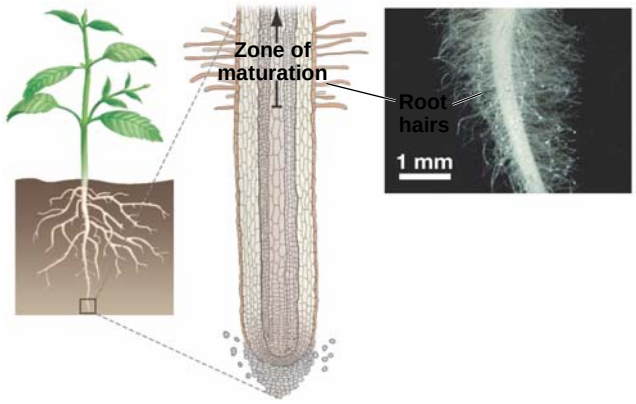
19

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).

20

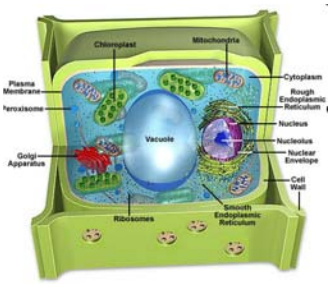
Root Hairs Increase the Surface Area Available for Nutrient Absorption



21

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.



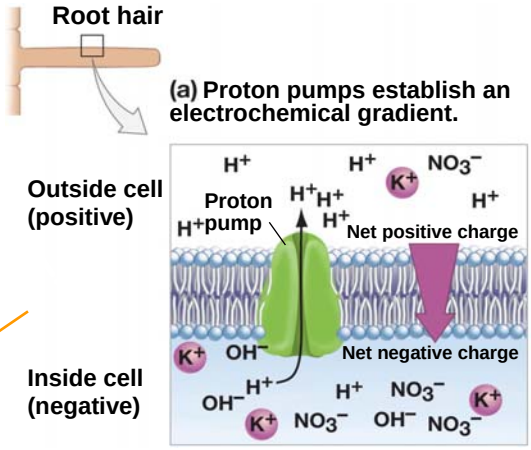
22

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.

23

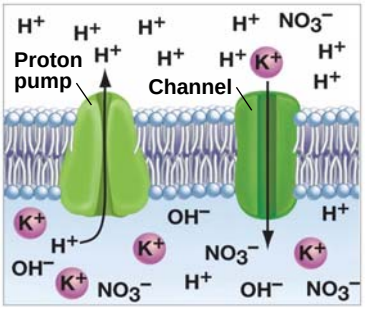
Ions Enter Roots along Electrochemical Gradients Created by



24

Cations Enter Roots via _____

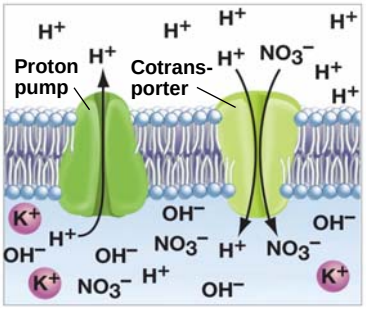
(b) Cations enter root hairs via channels.



25

Anions Enter Roots via _____

(c) Anions enter root hairs via cotransporters.



26

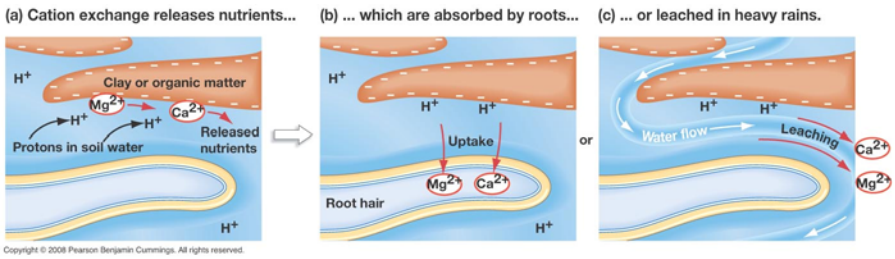
Cation vs Anion Nutrients

- 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

  - H^+ (proton) for Mg^+ or K^+ or Ca^+ etc.
  - Plants facilitate by pumping H^+ out of root hairs

27



H+ (proton) for Mg+ or K+ or Ca+ etc.

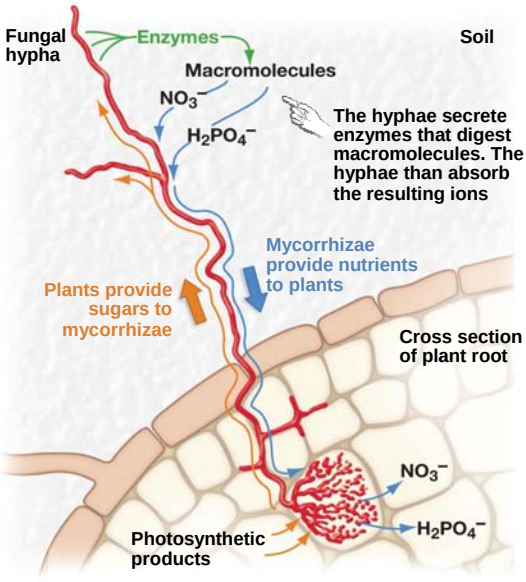
Plants facilitate by pumping H+ out of root hairs

28

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 _____

29



mycorrhizae provide _____ and/or _____ to the plants in exchange for sugar.

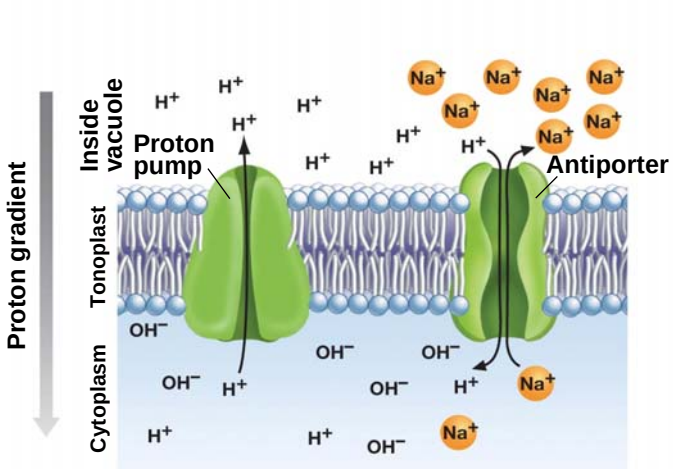
_____ mutualism

30

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.



31

'mummies'

Why are these all found in the same habitat?

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

BOGS

32

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

33

Nitrogen Fixation

- Plants and other eukaryotes cannot use N_2 from the atmosphere.
- However, some _____ are able to absorb N_2 from the atmosphere and convert it to ammonia, nitrates, and nitrites in a process called **nitrogen** _____.

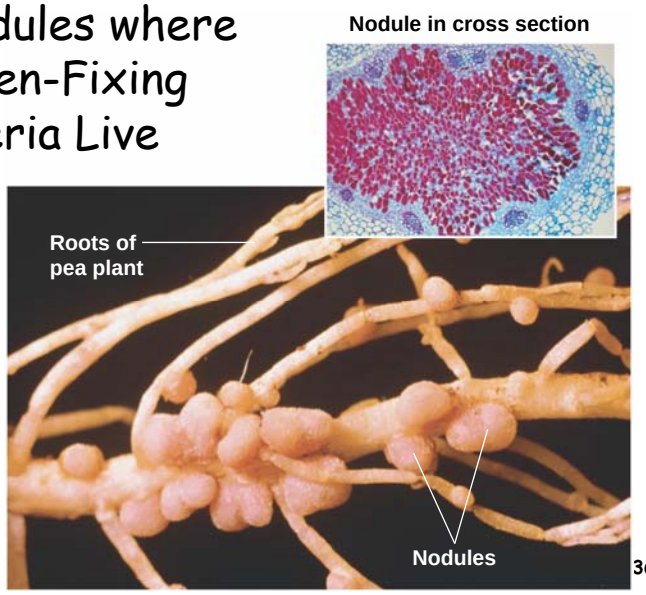
34

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



36

Nutritional Adaptations of Plants

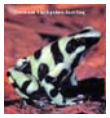
- Most plants use proton pumps as a mechanism for importing nutrients from the soil and/or acquire nutrients from symbiotes.
- In addition, 99% of plants make their own sugars.
- Some plants don't follow these rules, some appear to live on:
- 1) , some 2) others, some catch 3) .

37

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



38

Epiphytes Are Adapted to Grow in the Absence of Soil

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

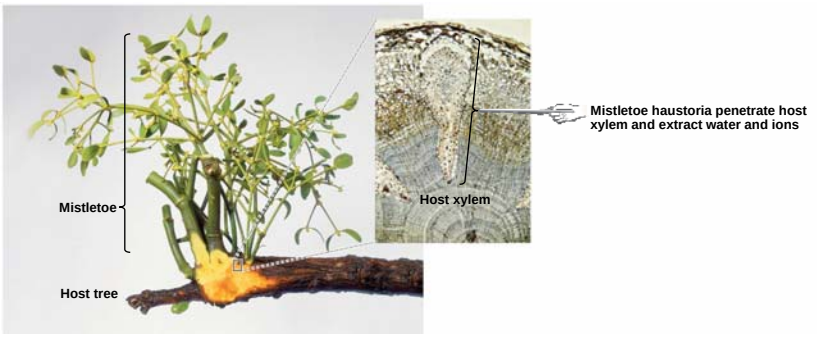
39

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

40

Some Plant Parasites Tap into the Xylem Tissue of Their Hosts



Mistletoe

41

42

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 _____ available in the environment, which is often lacking.

43

Sundews Have Modified Leaves with a Sticky Surface That Catches Insects

44