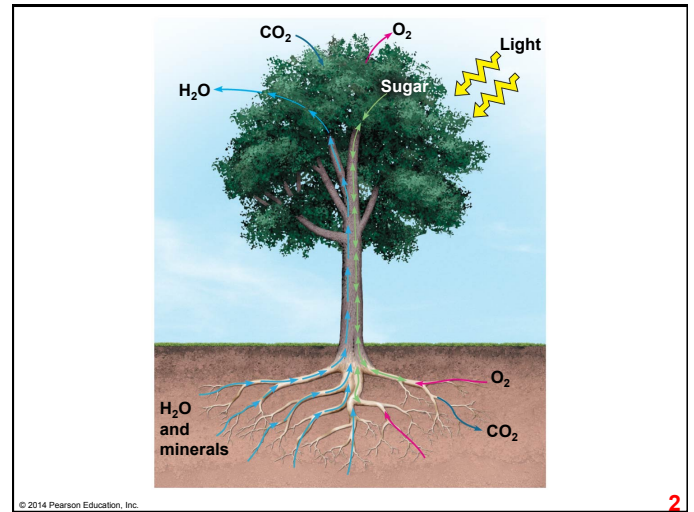
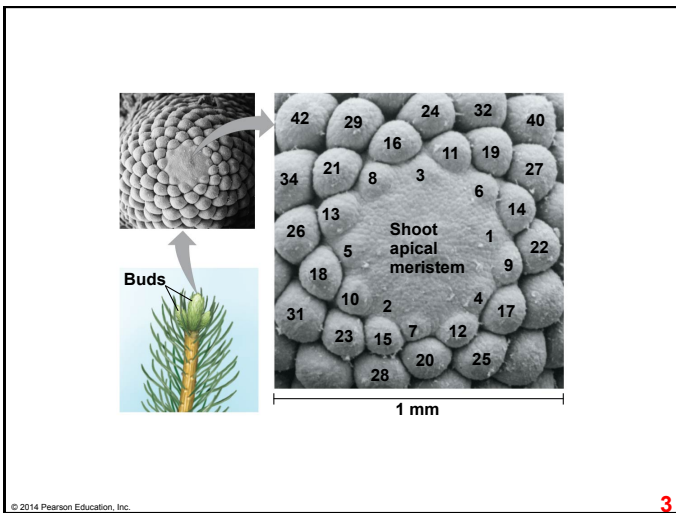




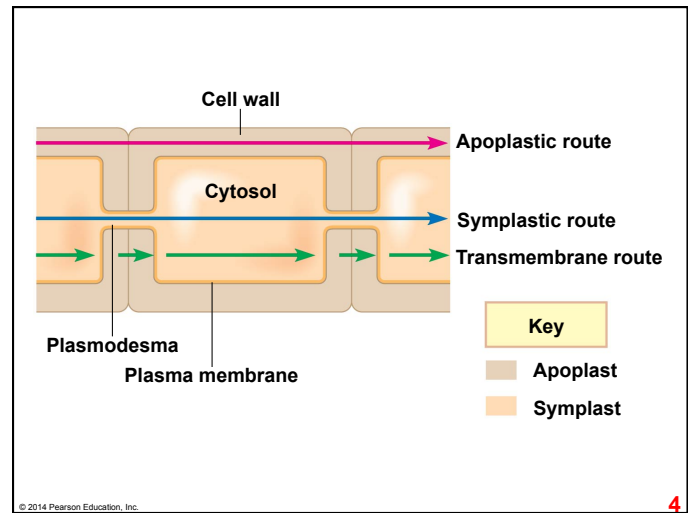
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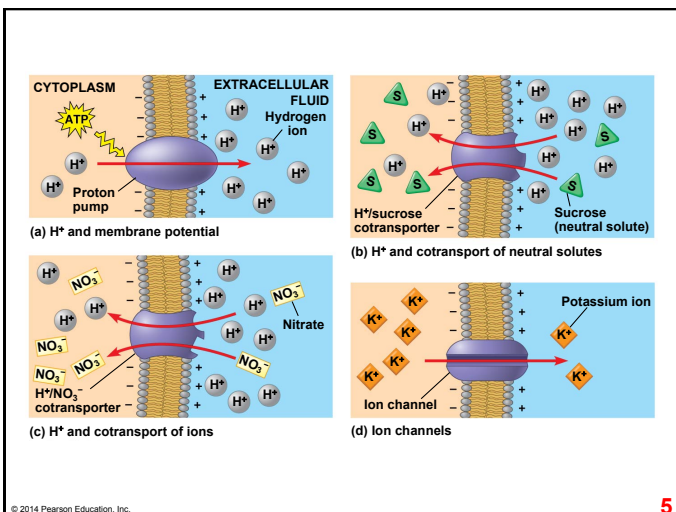
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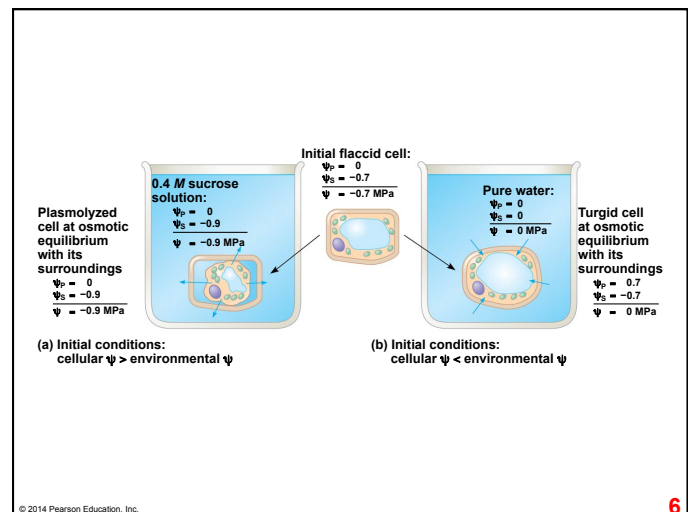
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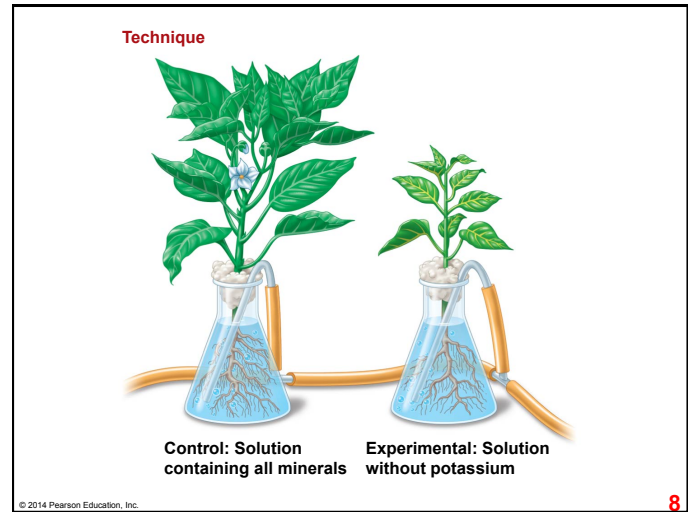
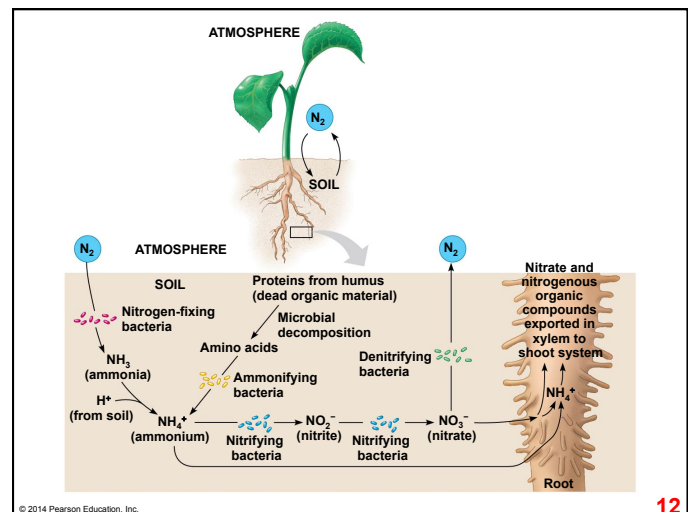
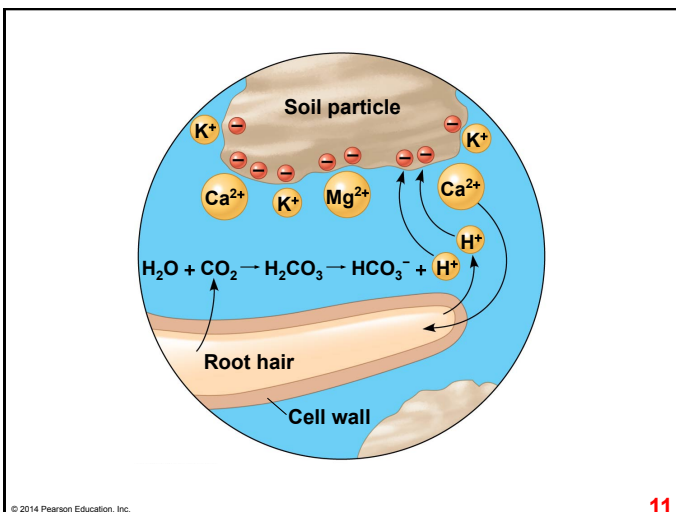
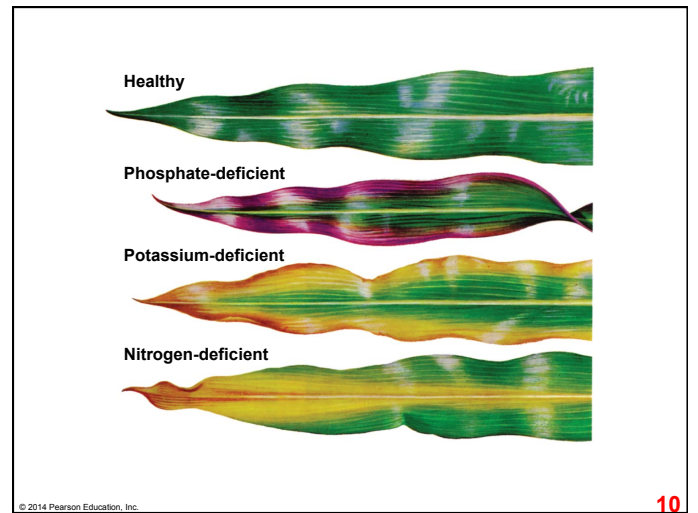


Table 29.1 Essential Elements in Plants

Element	Form Primarily Absorbed by 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%	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; cofactor and activator of 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; cofactor of some enzymes; needed for photosynthesis
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; cofactor of some enzymes; needed for DNA transcription
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 mutualistic relationship with nitrogen-fixing bacteria; cofactor in nitrate reduction

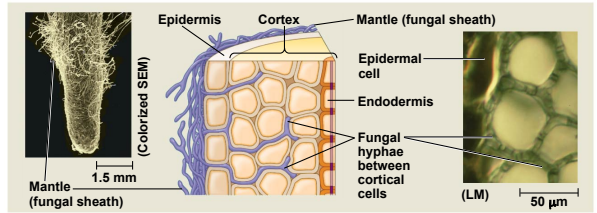
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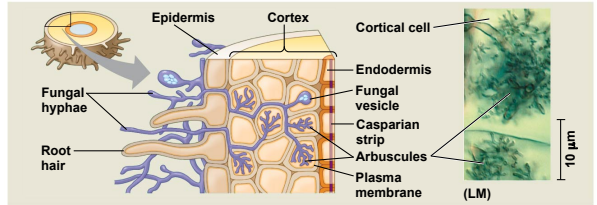


Nodules

Roots

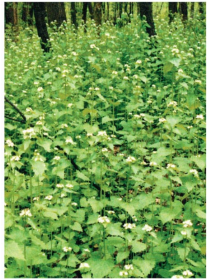


(a) Ectomycorrhizae

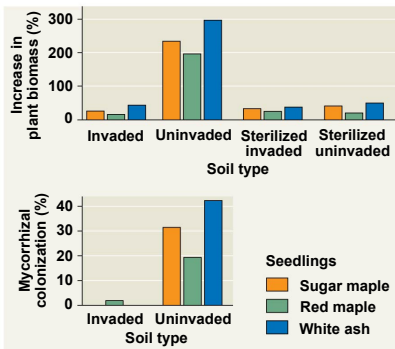


(b) Arbuscular mycorrhizae (endomycorrhizae)

Experiment

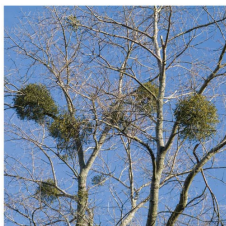


Results



Staghorn fern, an epiphyte

Parasitic plants



Mistletoe, a photosynthetic parasite



Dodder, a nonphotosynthetic parasite (orange)



Indian pipe, a nonphotosynthetic parasite of mycorrhizae

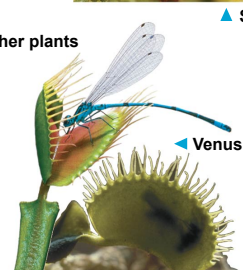
Carnivorous plants



Pitcher plants



Sundew



Venus flytraps

