Plant Nutrition and Transport Guided Notes 2025

Plants require 16 essential elements
All plants require several nutrients to stay healthy.
These plants have nutrient deficiencies.

16 essential elements
Essential elements are required for
metabolism, _____, and reproduction.

Essential elements: macronutrients
Macronutrients are required in large amounts. Carbon, oxygen, and hydrogen are the most abundant macronutrients.

Essential elements: micronutrients
Micronutrients are required in much smaller amounts.

Soil
Plant roots absorb nutrients from the soil.

What is soil?
Soil is a complex mixture of rock particles, organic matter, air, and water.

Soil is home to many organisms
Many organisms live in the soil, decomposing organic matter and releasing inorganic nutrients.

Soil layers: litter
Lying on the soil's surface is litter, which consists of decomposing leaves and stems.

Soil layers: humus
As microbes decompose the litter, carbon dioxide is released into the atmosphere. The carbon that remains in the soil forms a layer of soil called humus.

Soil layers: A horizon
Most humus is in the topsoil (the A horizon). This layer of soil also supplies most of a plant's water and nutrients.
Plant roots stabilize the topsoil, helping to prevent erosion.

Soil layers: B horizon
Below the topsoil is the B horizon, which has less organic matter. Roots extend into the B horizon.

Soil layers: C horizon
The C horizon mostly has weathered rocks.

Soil layers: bedrock
Below the C horizon is bedrock.

Plants obtain nutrients from soil and air

Symbiotic relationships with nitrogen-fixing bacteria help plants obtain useful forms of _____.

How plants obtain nutrients: nodules
Some nitrogen-fixing bacteria live in growths called nodules on the roots of plants.

How plants obtain nutrients: roots
Plants take up other nutrients through their roots as well. These nutrients dissolve in the soil's water and move into the plant as it absorbs water.

How plants obtain nutrients: gas exchange
Plants obtain carbon and oxygen from the atmosphere, in the form of CO_2.

Vascular tissue transports substances
Vascular tissue forms the transportation system that connects plant parts.
_____ and phloem function in different ways.

Vascular tissue transport: xylem
First, let's look at how water and minerals are pulled up to leaves in xylem.

Xylem transports water and minerals
Xylem transport is explained by cohesion-tension theory. _____ is the tendency for water molecules to form hydrogen bonds with one another.

1) Transpiration: Water molecules evaporate from leaves.
2) Xylem transport: Water molecules are Pulled up stem.
3) Absorption: Water molecules are pulled into roots.

Xylem and water transport: transpiration
Because of cohesion, when water evaporates from the leaves, in a process called transpiration, it pulls adjacent molecules closer to the stomata.

1) Transpiration: Water molecules evaporate from leaves.
2) Xylem transport: Water molecules are Pulled up stem.
3) Absorption: Water molecules are pulled into roots.

Xylem and water transport: diffusion
As the concentration of water within the mesophyll decreases, water molecules diffuse out of nearby _____. Those molecules, in turn, pull neighboring water molecules up the xylem.

1) Transpiration: Water molecules evaporate from leaves.
2) Xylem transport: Water molecules are Pulled up stem.
3) Absorption: Water molecules are pulled into roots.

Xylem transports water into tissues
This movement of water molecules is repeated all the way down the xylem. Along the way, water molecules diffuse into "_____" tissues.

1) Transpiration: Water molecules evaporate from leaves.
2) Xylem transport: Water molecules are Pulled up stem.
3) Absorption: Water molecules are pulled into roots.

Xylem and water transport: Casparian strip

Water molecules are pulled in to roots. The Casparian strip is a waxy barrier that ensures all incoming material passes through cells.

Xylem and water transport: stomata

A waxy layer on leaves called the cuticle helps prevent water loss.
Also, pores in leaves called stomata close when the plant needs to conserve water.

Xylem and water transport: guard cells

Guard cells determine whether a _____ is open or closed.

Phloem pushes sugars

Now, let's see how sugars are pushed to nonphotosynthetic cells in phloem.

Phloem and sugar transport: sources

The green leaves of this strawberry plant are sugar "sources" because they carry out photosynthesis.
Loading at the source

1) Solutes (sugars produced in photosynthesis) enter a sieve tube by active transport.
2) Water enters the sieve tube from the xylem by osmosis, increasing pressure in the sieve tube.

Phloem transport in sieve tube

3) Pressure pushes the solutes toward the sink.

Unloading at the sink

4) As the sink is reached, solutes are unloaded by facilitated diffusion or active transport into the sink cells.
5) Water moves out of the pholem to the xylem by _____, decreasing pressure in the sieve tube.

Phloem and sugar transport: sinks

Roots and fruits, which require sugar but do not carry out photosynthesis, are "sinks."

1) Solutes (sugars produced in photosynthesis) enter a sieve tube by active transport.
2) Water enters the sieve tube from the xylem by osmosis, increasing pressure in the sieve tube.

Phloem transport in sieve tube

3) Pressure pushes the solutes toward the sink.

Unloading at the sink

4) As the sink is reached, solutes are unloaded by facilitated diffusion or active transport into the sink cells.
5) Water moves out of the pholem to the xylem by _____, decreasing pressure in the sieve tube.

Phloem and sugar transport: pressure flow

According to pressure flow theory, phloem sap moves from high pressure at sources to low pressure at sinks. Water movement causes the pressure changes in the phloem tissue.

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Phloem transport in sieve tube

3) Pressure pushes the solutes toward the sink.

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4) As the sink is reached, solutes are unloaded by facilitated diffusion or active transport into the sink cells.
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Phloem and sugar transport: pathway of sugar flow
First, sugars are actively transported from photosynthetic cells to companion cells and then into the sieve tube.

Phloem receives water from the xylem
Then, water moves by osmosis from xylem into the sieve tube, increasing sieve tube pressure.

Pressure pushes sugars towards the sink
This pressure pushes the sugars toward the _____.

Sugars are deposited in the sink
At the sink, transport proteins move sugars out of the sieve tube. Since the solute concentration in the phloem decreased, water leaves the sieve tube by osmosis.

Loading at the source
Why fruits are sweet
Transport of sugars from sources to sinks explains how non-photosynthetic cells obtain sugars (and why fruits are often sweet).

Xylem and phloem
This figure summarizes xylem and phloem transport.

Phloem parasites
Parasitic plants tap into the vascular tissue of other plants. Mistletoe roots push through the epidermis of this tree, connecting to its xylem and phloem.