

# How Do Plants Get Water and Minerals?

## Properties of Water and Minerals

Water molecules carry partial charges

Relatively negative oxygen atoms in water molecules are attracted to relatively positive hydrogen atoms in other water molecules (cohesion)

Water is a powerful solvent with a very high capacity to dissolve molecules and atoms that carry charges

Basic minerals required by living things exist as ions (i.e., they carry positive or negative charges -  $\text{Zn}^+$ ,  $\text{K}^+$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{NH}_4^+$ ,  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{PO}_4^{3-}$ )

Hence, the minerals required by living things are dissolved in water

## Root functions

Anchoring the plant firmly to a substrate

Producing hormones

Absorbing water and minerals

## Root structure

### Outside to inside

Root hairs – Extensions of epidermal cells, which greatly increase surface area and, hence, the capacity of the root system to absorb water and minerals

Epidermis – The outermost cell layer of the root and other plant parts

Cortex – The primary tissue of the root, located between the epidermis and the endodermis, which is usually the site of carbohydrate storage

Endodermis – A cylinder of cells that separates the cortex from the vascular tissue

Stele – Area of the root containing the vascular tissue

Xylem – Vascular tissue involved with the transport of water and minerals

Phloem – Vascular tissue involved with the transport of sugars and other organic compounds along with water and minerals

## Entry of Water and Minerals

From the outside to the endodermis

Through the walls of the cells of the epidermis and the cortex

Through the interiors (protoplasm) of the cells of the epidermis (mainly via root hairs) and the cortex

Through the walls of the cells of the epidermis and then through the interiors of the cells of the cortex

Through the interior of the cells of the epidermis (mainly via root hairs) and then through the walls of the cells of the cortex

From the cortex through the endodermis to the vascular tissue

Water and dissolved minerals move from the cortex to the xylem of the stele only through the interior (protoplasm) of the cells of the endodermis; hence, potentially harmful minerals are selectively excluded

## Transport of Water and Minerals Throughout the Plant

Root pressure

Water and minerals that have already entered the xylem and are now above the root hair zone cannot reenter the cortex because of the watertight endodermis

Continued absorption of minerals and water in the root hair zone causes a build up of water pressure, called root pressure

Root pressure forces water and minerals up the root and stem inside the xylem

Cohesion-tension

Because of the cohesion of water molecules to one another, there is a continuous column of interacting water molecules in the xylem from the roots to the leaves

Evaporation of water from leaf tissues (transpiration) causes water to move from the xylem into the leaf tissues

As water molecules leave the xylem, they drag other water molecules along with them

Cohesive forces pull water upward through the xylem, all the way from the roots

Because minerals are dissolved in the water, they also move through the plant

This lecture outline was prepared partly from *Biology*, by Campbell and Reece, 2002 (6<sup>th</sup> edition), and from *Botany – An Introduction to Plant Biology*, by Mauseth, 1998 (2<sup>nd</sup> edition), and may contain phrases or entire sentences taken verbatim from those sources.