PLANT NUTRITION

ELEMENT	TYPICAL AMOUNT IN WHEAT PLANTS (mg/g dry matter)	USE IN PLANTS	DEFICIENCY EFFECTS
Nitrogen	40	Amino acids and proteins	Poor growth, yellow leaves
Sulphur	3	Proteins	Yellow leaves
Phosphorus	3	Nucleic acids and ATP	Poor growth, leaves dull green with curly brown edges
Potassium	35	Helps protein and chlorophyll formation, & resistance to disease	Yellow edges to leaves, die early
Calcium	3	Cell formation	Poor buds, stunted growth
Magnesium	2	Needed for chlorophyll formation	Yellow leaves
Iron	0.1	Needed for chlorophyll formation	Yellow leaves

OVERVIEW OF TRANSPORT IN TRACHEOPHYTE PLANTS

WHERE TRANSPORT OCCURS	SUBSTANCES TRANS-PORTED	METHOD OF TRANS-PORTATION	DIRECTION OF MOVEMENT	REASON FOR MOVEMENT
Soil to root hair	Water and soluble nutrients	Osmosis and active transport	Into plant	To provide water required for photo-synthesis, to provide turgidity necessary to open stomata for gas exchange and transpiration
Root hair to root cortex	As above	Osmosis through cell cytoplasm and vacuoles	Into plant	As above
Root cortex to xylem	As above	Diffusion through cell wall pores and inter-	Into vascular bundle (Xylem)	As above

		cellular air spaces		
VASCULAR BUNDLES (a) xylem to leaf cells containing chlorophyll	As above	Osmosis, diffusion, transpiration pull, root pressure	Upwards to leaves	To provide water to cells in leaf (Mesophyll) that contain chlorophyll for photosynthesis
(b) phloem to cells containing mitochondria	Soluble inorganic ions, organic material (sucrose and amino acids)	Active transport	Up and down	To provide nutrients to cells for respiration
Cells to stomata	Water and carbon dioxide	Diffusion	Out of plant	Reduces carbon dioxide concentration in plant and remove water (by-product of respiration)

Refer to diagrams of the root, stem, and leaf cross-sections as well as stomata in your textbook.

THE ROOT

4 Root Regions are:

1. Root Cap – a toughened thimble-shaped covering of cells on the tip of the root
2. Meristem – the region of greatest cell division (mitosis) from which all root cells are produced
3. Zone of Elongation – the region where cells elongate to lengthen the root by taking in water
4. Zone of Maturation – the region containing root hairs, and where the cells differentiate into the permanent cells of the root

Cross-Section of the Zone of Maturation

- Epidermis – outer layer that produces root hairs and protects underlying cells
- Cortex – layer beneath epidermis; contains the vascular bundles with xylem (carrying water and mineral ions), phloem (carrying nutrient-rich sap) and cambium between them (gives rise to new xylem and phloem cells)

Movement of Water and Mineral Ions into the Root

- Water diffuses from soil into root through root hairs.
- Ions enter by active transport.
- The entry of water into the xylem vessels of the root builds up root pressure that aids in upward movement of water.

THE STEM

Cell Wall and Cytoplasmic Pathways

After water and mineral ions have been taken into the root, they travel through the plant either between the cell walls of plant cells (Cell wall pathway) or from cell to cell through the cytoplasm (Cytoplasmic pathway).

Stem Structure

- Epidermis – outer layer of the stem; may be covered by a layer called the cuticle for protection; replaced by bark in a woody plant
- Cortex – layer beneath the epidermis
- Vascular Bundles – These are groups of outer phloem (carrying sugar-rich sap), inner xylem (carrying water and mineral ions), and cambium in between (gives rise to both phloem and xylem vessels.
  Xylem is composed of long dead water-filled xylem vessels whose cell walls are strengthened by lignin and whose ends have holes for water flow, tracheids, supporting fibres and parenchyma cells.
  Phloem is composed of living sieve tubes, parenchyma cells (especially a special kind called companion cells, and supportive fibres.
- Pith the inner area composed of large parenchyma cells which serve as storage places

Transport of Water, Mineral Ions and Nutrients in the Stem

- Diffusion and osmosis allow water and mineral nutrients to travel up the xylem from root to leaf. Also root pressure and capillary action aid in this.
- Diffusion and osmosis also allow the two-way movement of nutrients such as sugar through the phloem.
- Turgor Pressure is the pressure within plant cells due to amount of water. A plant wilts when there is a lack of water and reduction in turgidity.

Other Features of Stems

- Underground Stems – Ferns and grasses have underground stems called rhizomes. Potatoes have underground stems adapted for food storage called tubers. Onions have underground stems modified into bulbs.
- Herbaceous and Woody Plants – Herbaceous plants without bark are often annuals (life cycle of one year) or biennials (life cycle of two years). Woody plants with bark are often perennials, lasting many years.
- Annual Rings – yearly deposits of xylem
- 'Ring-barking' – the process of cutting a circle through the bark and phloem, and allowing the tree to die slowly
- Lenticels – groups of loosely-packed cells that allow gas exchange across the otherwise airtight waterproof cork covering the stems of plants

THE LEAF

Leaf Cross-Section

- Upper and Lower Epidermis – protective layers on the upper and lower sides of the leaf

- Cuticle – waxy layer on the upper epidermis to reduce water loss
- Palisade Cell Layer – layer without chloroplasts beneath the upper epidermis
- Spongy Mesophyll Layer – layer beneath palisade layer containing chloroplasts; also contains veins carrying xylem and phloem, and many air spaces for exchange of carbon dioxide and oxygen
- Stoma (Plural: Stomata) – pores in the lower epidermis that are surrounded by bean-shaped guard cells that contain chloroplasts

Action of Stomata

- In general, stomata open in the presence of light and close in the dark.
- The bean-shaped guard cells have thicker walls on the side toward the stoma than on the other sides.
- As glucose is produced and builds up in the guard cells during photosynthesis, water is drawn into the cells by osmosis. This increase the turgor pressure and the guard cells change shape, opening the stoma.

Transport of Water, Mineral Ions and Nutrients in the Leaf

- Transpiration is the water loss that occurs through the open stomata. This loss helps to draw water up through the xylem from the root.
  Factors that affect transpiration are temperature, light intensity and duration, wind speed and relative humidity.
- Diffusion, osmosis and capillary action also play a role in transport through the phloem and xylem of veins. Much of the glucose produced in the leaf in the day is converted to starch in the leaf. It is then converted back into glucose for transport in phloem. If stored in root or stem, it is changed back into starch in most plants. The movement of glucose is called translocation.
- Guttation only occurs in some plants and is the loss of water through special pores at the ends of leaf veins. Droplets are produced as a result of root pressure.
- Aquatic plants such as water lilies have the stomata on the upper side of the leaf.

*Did You Know That…?*The tips of the stinging hairs of stinging nettles are actually made of glass that the plants manufacture from silicon in the soil.