Plant Science

# Topic 9

9.1 – Transport in the xylem of plants

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| **Essential Idea:** Structure and function are correlated in the xylem of plants | |
| **Nature of Science:** Use models as representations of the real world—mechanisms involved in water transport in the xylem can be investigated using apparatus and materials that show similarities in structure to plant tissues. (1.10) | |
| **Understandings:**   * Transpiration is the inevitable consequence of gas exchange in the leaf. * Plants transport water from the roots to the leaves to replace losses from transpiration. * The cohesive property of water and the structure of the xylem vessels allow transport under tension. * The adhesive property of water and evaporation generate tension forces in leaf cell walls. * Active uptake of mineral ions in the roots causes absorption of water by osmosis.   **Applications and skills:**   * Application: Adaptations of plants in deserts and in saline soils for water conservation. * Application: Models of water transport in xylem using simple apparatus including blotting or filter paper, porous pots and capillary tubing. * Skill: Drawing the structure of primary xylem vessels in sections of stems based on microscope images. * Skill: Measurement of transpiration rates using potometers. (Practical 7) * Skill: Design of an experiment to test hypotheses about the effect of temperature or humidity on transpiration rates. | **Utilization:**  Syllabus and cross-curricular links:  Biology  Topic 2.2 Water  Topics 2.9 and 8.3 Photosynthesis  Review:  Topic 1.2 Ultrastructure of Cells  Topic 1.4 Membrane Transport  Topic 2.1 Molecule to Metabolism  Topic 2.2 Water  Topic 2.3 Carbohydrates and Lipids Topics 2.9 and 8.3 Photosynthesis  **Aims:**   * **Aim 7:** The introduction of image processing software and digital microscopes increases further the ability to gather more data to ensure reliability. * **Aim 6:** Measurement of stomatal apertures and the distribution of stomata using leaf casts, including replicate measurements to enhance reliability, are possible experiments |
| Labs:   * Stomatal density (Data Analysis) * The effect of humidity and wind on the rate of transpiration (Data Analysis and Conclusion) | |

9.2 – Transport in the phloem of plants

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| **Essential Idea:** Structure and function are correlated in the phloem of plants | |
| **Nature of Science:** Developments in scientific research follow improvements in apparatus—experimental methods for measuring phloem transport rates using aphid stylets and radioactively-labelled carbon dioxide were only possible when radioisotopes became available. (1.8) | |
| **Understandings:**   * Plants transport organic compounds from sources to sinks. * Incompressibility of water allows transport along hydrostatic pressure gradients. * Active transport is used to load organic compounds into phloem sieve tubes at the source. * High concentrations of solutes in the phloem at the source lead to water uptake by osmosis. * Raised hydrostatic pressure causes the contents of the phloem to flow towards sinks   **Applications and skills:**   * Application: Structure–function relationships of phloem sieve tubes. * Skill: Identification of xylem and phloem in microscope images of stem and root. * Skill: Analysis of data from experiments measuring phloem transport rates using aphid stylets and radioactively-labelled carbon dioxide. | **Utilization:**  Syllabus and cross-curricular links:  Biology  Topic 1.4 Membrane Transport |

9.3 – Growth in plants

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| **Essential Idea:** Structure and function are correlated in the xylem of plants | |
| **Nature of science:** Developments in scientific research follow improvements in analysis and deduction—improvements in analytical techniques allowing the detection of trace amounts of substances has led to advances in the understanding of plant hormones and their effect on gene expression. (1.8) | |
| **Understandings:**   * Undifferentiated cells in the meristems of plants allow indeterminate growth. * Mitosis and cell division in the shoot apex provide cells needed for extension of the stem and development of leaves. * Plant hormones control growth in the shoot apex. * Plant shoots respond to the environment by tropisms. * Auxin efflux pumps can set up concentration gradients of auxin in plant tissue. * Auxin influences cell growth rates by changing the pattern of gene expression.   **Applications and skills:**   * Application: Micropropagation of plants using tissue from the shoot apex, nutrient agar gels and growth hormones. * Application: Use of micropropagation for rapid bulking up of new varieties, production of virus-free strains of existing varieties and propagation of orchids and other rare species. | **Utilization:**  Syllabus and cross-curricular links:  Biology  Topic 3.5 Genetic modification and biotechnology  Review:  Topic 1.4 Membrane Transport  Topic 1.6 Cell Division   **Aims:**   * **Aim 6:**Investigations into tropisms could be carried out. |

9.4 – Reproduction in plants

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| **Essential Idea:** Reproduction in flowering plants is influenced by the biotic and abiotic environment. | |
| **Nature of science:** Paradigm shift—more than 85% of the world’s 250,000 species of flowering plant depend on pollinators for reproduction. This knowledge has led to protecting entire ecosystems rather than individual species. (2.3) | |
| **Understandings:**   * Flowering involves a change in gene expression in the shoot apex. * The switch to flowering is a response to the length of light and dark periods in many plants. * Success in plant reproduction depends on pollination, fertilization and seed dispersal. * Most flowering plants use mutualistic relationships with pollinators in sexual reproduction.   **Applications and skills:**   * Application: Methods used to induce short-day plants to flower out of season. * Skill: Drawing internal structure of seeds. * Skill: Drawing of half-views of animal-pollinated flowers. * Skill: Design of experiments to test hypotheses about factors affecting germination. |  |
| Labs:  Design an experiment to test how a factor affects germination (design, data collection and analysis, conclusion) | |