

UNIT 3: Plant Nutrition and Transport

Recommended Prior Knowledge Students should know something of carbohydrates and proteins, the structure of a plant cell, and osmosis, all of which were dealt with in Units 1 and 2. They should have an understanding of energy transfers from one form to another.

Context This Unit builds on ideas from Units 1 and 2. Concepts from this Unit will be revisited in Units 9 and 10.

Outline This Unit covers most of the plant physiology topics. There is a considerable range of practical work that can be carried out, much of which can be used to develop or to assess practical skills. Teachers working in countries where there are marked seasons will need to take this into consideration when planning the timing of this Unit. The Unit begins by looking at the way in which plants manufacture organic substances using sunlight and inorganic molecules as their raw materials. Extension candidates look a little more deeply into the way in which environmental factors affect the rate of photosynthesis, and how these factors can be controlled in glasshouse cultivation. Knowledge of cell structure, covered earlier in Unit 1, is extended to look more fully at the structure and function of cells and tissues in a leaf, and the idea of adaptation of structure to function is re-emphasised. The movement of water from soil to air in xylem, and of organic products of photosynthesis in phloem, is considered. Extension candidates should think about a range of examples of adaptations of plants to living in extreme conditions. Some wider issues relating to this Unit, such as the position of plants as producers in an ecosystem, and problems associated with the use of fertilisers and pesticides, will be considered in Unit 10.

| | Learning Outcomes | Suggested Teaching Activities | Online Resources | Other Resources |
|---------------------------|--|--|--|-----------------|
| II 6.2.1 | Define photosynthesis and state the equation for the production of simple sugars and oxygen in either words or symbols describe the intake of the raw materials, the trapping and storing of energy (conversion of light energy into chemical energy) and the formation of food substances and their subsequent storage. | Plants can be considered as 'food factories', in which all the food in the world is initially made. Students should compare the needs of animals for organic nutrients (covered in Unit 2) with those of plants, which only require inorganic ones such as carbon dioxide and water. The initial products of photosynthesis are sugars (such as glucose) which can then be converted to large, insoluble molecules such as starch for storage. The process of photosynthesis should be considered at a fairly basic level; there is no need to introduce the ideas of light-dependent and light-independent stages. The important point to get across is the | Photosynthesis http://eduref.org/cgi-bin/printlessons.cgi/Virtual/Lessons/Science/Botany/BOT0046.html Simple photosynthesis experiments Investigating the behaviour of leaf discs http://www-saps.plantsci.cam.ac.uk/worksh eets/activ/prac5.htm Instructions for a slightly different way of investigating the production of starch during photosynthesis, using leaf discs. | |

IGCSE BIOLOGY 0610 SCHEME OF WORK

| | | | | |
|---------------------|---|--|--|--|
| | | <p>conversion of light energy to chemical energy. Chlorophyll absorbs light energy and enables it to be used to drive the reactions. (Ensure that students do not think that chlorophyll attracts light!)</p> <p>There is a wide variety of practical work that can be carried out. Students should know how to test a leaf for starch, and carry out simple experiments into the need for light and chlorophyll for photosynthesis.</p> | | |
| II 6.2.1 | <p>Define the term limiting factor, interpret (as limiting factors which affect photosynthesis) the effects of light intensity and carbon dioxide concentration explain the use of carbon dioxide enrichment, optimum light and optimum temperatures in greenhouse systems.</p> | <p>Limiting factors should be dealt with relatively simply, as anything which limits the rate of photosynthesis if it is in short supply. Simple graphs can be sketched showing the effect of increasing light intensity or carbon dioxide concentration on the rate of photosynthesis, and students should be able to explain why such a graph initially rises and then flattens out. They can use Elodea or other water plants to investigate the effects of light intensity on the rate of oxygen production.</p> <p>Greenhouse systems are most widely used in temperate countries, and students living in countries where their use is not widespread should be prepared to consider the need for them in relatively cool climates.</p> | <p>Various teacher and student resources on photosynthesis (register to use site) \$http://www.riverdeep.net/science/biology_explorer/be_activity_pages/catn.activityi_393.html;\$sessionid\$1RXTXLJNV MGACQFAGMCIIQKAUA ZOI5G)</p> | |

IGCSE BIOLOGY 0610 SCHEME OF WORK

| | Learning Outcomes | Suggested Teaching Activities | Online Resources | Other Resources |
|-------------|--|--|---|-----------------|
| II 6.2.2 | Identify the cellular and tissue structure of a dicotyledonous leaf, as seen in cross section, and demonstrate the significance of these features in terms of functions, i.e. distribution of chloroplasts – photosynthesis stomata and mesophyll cells – gaseous exchange vascular bundles (xylem and phloem) - transport | <p>Before considering the appearance of a section through a leaf, students should look at entire leaves and consider how they are adapted for photosynthesis. A transparency of a section through a leaf can be projected and discussed, before a simplified diagram is made of a leaf section. Students should already be familiar with the structure of a palisade cell, and can now consider it as part of tissue that is specialised for photosynthesis.</p> <p>It can be helpful to think of a leaf as a food factory, and then to consider how the raw materials are brought to it, and how the products are removed for distribution.</p> <p>Drawings of leaves, and comparisons between two or more different kinds of leaves, make good practice or assessment material for the practical skills of observation and recording, and also for magnification calculations.</p> <p>It is probably best not to go into any detail at this point about xylem and phloem function; they will be dealt with a little later.</p> | Photomicrograph of Eleagnus leaf TS with vascular bundle http://images.botany.org/set-13/13-063v.jpg | |
| II 6.2.3 | Describe: the importance of nitrate ions for protein synthesis and magnesium ions for chlorophyll synthesis. | Students should be reminded that carbohydrates contain carbon, hydrogen and oxygen only; plants can therefore make these from carbon dioxide and water. However, proteins also contain nitrogen, so a nitrogen source is necessary before some of the carbohydrate can be converted to protein. Nitrate ions from the soil are the main source of nitrogen for plants. For | | |

IGCSE BIOLOGY 0610 SCHEME OF WORK

| | | | | |
|---------------------|---|---|---|--|
| | | <p>extension candidates, a link can be made back to the uptake of ions by root hairs (II.3).</p> <p>It may be best not to deal with the use of nitrogen fertilisers here, but rather to cover this fully in Unit 10 (IV.5.1).</p> | | |
| II 6.2.3 | Explain the effects of nitrate ion and magnesium ion deficiency on plant growth. | This should be dealt with simply, considering the effects on a growing plant of a shortage of proteins or chlorophyll. | | |
| II 7.1.1 | Identify root hair cells as seen under the light microscope and describe their functions describe the passage of water through root, stem and leaf. | <p>Root hair cells may already have been covered in Unit 1 (section II.2) as an example of a specialised cell, but here they are dealt with in the context of the whole plant. Osmosis should be revised, before discussing the uptake of water through the soil, across the root, and up through xylem.</p> <p>Xylem, also, may have already been discussed in Unit 1 (section II.2) and Unit 2 (II.6.2.2). Here it is considered in the context of water transport from root to leaves. If the structure of xylem vessels has not already been dealt with, then it should be simply covered here. No detail is required other than the idea that a xylem vessel is made of a long column of dead, empty cells with lignified walls, stacked end to end.</p> <p>Students will find the path taken by the water easier to understand if they have a simple knowledge of the position of the vascular bundles in the plant. Simple diagrams can be made of a TS of a root and of a stem, showing the xylem and phloem.</p> | <p>Roots http://www.ffp.csiro.au/research/mycorrhiza/root.html Diagrams & descriptions of root structures</p> | |

IGCSE BIOLOGY 0610 SCHEME OF WORK

| | | | | |
|-----------------------------------|---|---|--|--|
| | | <p>Large and semi-transparent stems, such as the leaf petioles of celery, can be placed with their bases in a solution of a water-soluble dye. After some time, the dye can be seen in the xylem vessels, spreading out into the veins in the leaves. If thin sections are cut, the positions of the xylem vessels show up clearly.</p> | | |
| <p>II 7.1.2</p> | <p>Define transpiration Describe: How water vapour loss is related to cell surfaces, air spaces and stomata. The effects of variation of temperature, humidity and light intensity on transpiration rate. How wilting occurs.</p> | <p>It is important to understand that transpiration involves the loss of water vapour from the leaf, mostly through open stomata. Water in the cell walls of mesophyll cells evaporates, and diffuses through the air spaces and out of the leaf.</p> <p>Experiments using potometers not only help students to understand the effects of environmental factors on the rate of transpiration, but also provide good opportunities to improve, or to be assessed on, all four experimental skills. It is important, however, that it is understood that a photometer measures water uptake, which is not absolutely the same as water loss. There is no need for elaborate potometers; all that is needed is a long piece of capillary tubing with a length of rubber tubing at one end into which the cut end of a shoot is pushed. Keep everything under water while assembling the apparatus, to avoid air locks.</p> <p>If students are shown a wilting plant, they can think about why it is only the leaves that wilt. This can introduce the idea of xylem vessels, present in vascular bundles</p> | <p>Transpiration described & experiment to carry out http://www.mcgrawhill.ca/school/booksites/sciencefocus+8/student+resources/by+resource+type/cool+stuff+to+see+and+do/unit+2+topic+5+hands+on+activities.php</p> | |

IGCSE BIOLOGY 0610 SCHEME OF WORK

| | | | | |
|---------------------------|---|---|---|--|
| | | in leaves and stem, helping with support. Wilting is a good way for a plant to avoid further water loss, by reducing the leaf area from which evaporation can occur. | | |
| II 7.1.2 | Describe the mechanism of water uptake and movement in terms of 'pull' from above, creating a water potential gradient through the plant. | Extension candidates will probably already have met the term 'water potential', in Unit 1 (section II.4). In normal conditions, the water potential in the air is lower than that in the soil solution. Thus water moves down a water potential gradient as it moves from soil to air, through the plant. The effect of transpiration in pulling water up xylem vessels can be compared to the effect of sucking a liquid up a straw. | | |
| II 7.1.2 | Describe the adaptations of the leaf, stem and root to different environments, with emphasis on local examples. | Although students should look at examples of plant adaptations using plants that grow locally, it is also very useful to think about plants that grow in especially wet or dry environments, such as rain forest or desert. | Desert plant survival http://www.desertusa.com/du_plantsurv.html Good descriptions of plant adaptations for survival in hot, dry regions. Plant adaptations http://www.microscopyuk.org.uk/mag/articles/anne1.html Microscope images of xerophytes and hydrophytes (plants that live in water), emphasising their adaptations. TS Marram grass photomicrograph http://www.microscopyuk.org.uk/schools/mainscol.html#plant | |
| II 7.1.3 | Define translocation in terms of the movement of sucrose and amino acids from regions of production or of storage to regions of utilisation in respiration or | This idea will probably already have been met earlier in this Unit, when discussing the functions of leaves. Here it should be reemphasised that carbohydrates are | | |

IGCSE BIOLOGY 0610 SCHEME OF WORK

| | | | | |
|---------------------------|---|--|--|--|
| | growth. | <p>transported through a plant in the form of sucrose, through phloem. No detail of phloem structure or function is required. It should be made clear that substances can be transported in any direction in phloem, for example from photosynthesising leaves down to roots, or from storage organs such as root tubers upwards to leaves and flowers.</p> <p>Consideration of the effects of 'ringing' a tree can help students to bring together their knowledge of stem structure and function. Ringing removes the phloem, which is near to the surface of a stem. If the ring is cut below the leaves, then all the cells beneath the ring are deprived of products of photosynthesis from the leaves, and eventually die.</p> | | |
| II 7.1.3 | Describe translocation, throughout the plant, of applied chemicals including systemic pesticides. | Students should understand that systemic pesticides are sprayed onto the plant, and then absorbed by it. They move through the plant in the phloem, and are taken in by any insect eating the plant or sucking up phloem sap. | | |