AS and A LEVEL

Delivery Guide

H022/H422

BIOLOGY B (ADVANCING BIOLOGY)

Theme: Transport Systems in Plants 2.2.4

June 2015

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CONTENTS

Introduction

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- Content: A clear outline of the content covered by the delivery guide;
- Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resourcesfeedback@ocr.org.uk

KEY

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AS Level only — AS Level content only

Thinking Conceptually

The first learning outcome can be linked with that of **2.2.1** which has the benefit of consolidating the concepts surrounding the need for a transport system in multi-cellular organisms.

Few students will have studied plant transport systems in depth and delivery of lessons can begin with a review of what students already know and understand. Interest can be stimulated and misconceptions can be avoided by allowing students to immerse themselves in microscopy and photomicrographs of plant vascular tissue.

Approaches and activities outlined in the contextual section below could usefully be introduced right from the start of the teaching of this topic.

Students may be unfamiliar with dissection when applied to plant tissue but such activities enable students to grasp the concepts of how xylem vessels and phloem sieve tubes show adaptations for transport of water and sugars respectively.

Key terms of monocotyledonous and dicotyledonous can be considered in detail (see reference 1 below for more details).

This leads naturally into the processes of transpiration and translocation.

A common misconception is that water loss from leaves is a consequence of water being absorbed in the roots and time spent completing practical work to look at factors such as: number or size of leaves; number of stomata; presence of a waxy cuticle; light intensity; relative humidity and temperature will aid understanding of transpiration.

Lessons covering the process of translocation can be delivered using computerised animations and discussion surrounding the theories of mass flow as described in the learner activities (see 2 and 3 below). Thorough, in-depth coverage at this stage will aid understanding of concepts in food production **(4.3.1 (for A Level students only))** as they appear later in the course.

Activities	Resources
1. everything science website – structure of transport systems in plants http://m.everythingmaths.co.za/science/lifesciences/grade-10/05-support-and-transport-systems-in-plants A good website for studying vascular tissue in monocotyledons and dicotyledons. **2. Science Aid website - translocation** http://scienceaid.co.uk/biology/plants/translocation.html **3. Biology innovation website - translocation** http://www.biology-innovation.co.uk/pages/plant-biology-ecology/phloem/ Both websites will aid students in understanding the mass flow theory and considering evidence.	

ACTIVITIES

There are many activities to support the delivery of this topic. The concept of why a transport system is needed in multicellular plants is addressed by a linked activity **(2.2.1 The heart and monitoring heart function)**.

The microscope work **(**relates to **PAG1)** and dissection **(**relates to **PAG2**) of plant material (Learner Activities 1 and 2) encourage students to learn and then apply knowledge of transport systems in vascular plants to observations of the actual tissues whilst gaining valuable practical skills. Mathematical concepts are embedded within Learner Activity 2 enabling students to gain confidence in manipulating equations and using appropriate units **(M0.1, M1.8)**. The plant material used also gives the student experience of different viewing aspects of the material e.g. transverse or longitudinal, and of differences in structure between species eg monocotyledon or dicotyledon.

Opportunity for using a potometer **(**relates to **PAG5**) arises when studying transpiration but, in Learner Activity 3, a simple set up is used for estimating transpiration rate involving loss of mass. Skills of recording, analysing, calculating ***(M0.1, M0.2, M1.1, M1.2, M1.3, M1.6,M1.11, M3.1, M3.2, M3.3, M3.5, M3.6, M4.1)*** and evaluating are all embedded in this activity (Learner Resource 2).

For consolidating student understanding of translocation there are a number of summary-type activities to enable students to work individually or in small groups to demonstrate what they know and understand. Producing a newspaper report (Learner Resource 3) which describes the mechanism for translocation allows students to 'put a spin' on known theories and class discussion. Using evidence to formulate arguments for and against the mass flow mechanism provides alternative ways for developing and assessing understanding.

Thinking Contextually

Activities	Resources
Learner Activity 1 (relates to PAG1) **Observation of plant tissues involved in transport of materials through the plant.** This activity supports individual or paired microscope work to observe plant tissues. Using prepared microscope slides of stem and root tissue, students observe, draw and annotate their field of view, including calculation of magnification and size of object. • Place the prepared slide of chosen plant tissue under the microscope, view using the lowest power objective lens first, then change the objective lens to increase magnification and choose an appropriate magnification to view and draw the tissues. • Determine the diameter of your field of view. Ideally use an eyepiece graticule and calibrate it using a stage micrometer (an important aspect of **PAG1**). This will make it easy to make multiple measurements of features within your sample. If eyepiece graticule and stage micrometer are not available, use a reference sample, such as the edge of a transparent ruler to estimate the diameter of the field of view. • Using Learner Resource 1, identify the different types of vascular tissue in your field of view*. • Draw what you see, annotate your diagrams, include scale bar and calculate (and state!) the magnification. • Use your field of view calculations or the eyepiece graticule to determine the diameter ** of a xylem vessel. Check this corresponds with your drawing. * Dependent on the prepared slide, you will be aiming to identify: xylem vessels, sieve tube elements and companion cells. ** section being observed should be transverse section of the stem/root **You tube submission - calculations from field of view** http://www.youtube.com/watch?v=WCq86u4kF58 A good clip tutorial for how field of view is calculated without using a graticule and stage micrometer.	Learner Resource 1 Click here to view

Thinking Contextually

Activities	Resources
Learner Activity 2 (relates to PAG2) **Dissection and examination of plant organs.** Due to the ease of obtaining celery and carrot samples, it should be possible for students to complete this activity individually or in pairs rather than use whole class demonstration. Specimens should be obtained with leaves still attached. Hand lenses can be used to examine tissues but also microscope slides can be prepared of thin samples. **Root** 1) Using the carrot, start by carefully making a cut at the stem end of the root. **Note** the very short stem of the carrot. Pare out a longitudinal section into the centre of the carrot and examine the tissues. 2) Make a transverse cut further down the carrot and once again examine the tissues. **Stem** 1) Place the celery stems root end down in water containing food dye and leave overnight. 2) Slice thin sections from the base of the celery stem and observe which areas have taken up the dye. 3) Take a celery stem and strip out one of the stained vessels. Observe the tissues using the hand lens or microscope. **edh website – organ dissection** http://edhsgreensea.net/PASS/Carrot_Dissection.pdf Provides ideas for worksheet for plant dissection.	Click here

Thinking Contextually

Activities	Resources
Learner Activity 3 **Estimating rate of transpiration from a plant cutting.** In this activity, students work in pairs or small groups. Each group can be given a different species of plant to take cuttings from and information shared about transpiration rates as a whole class discussion. Note: To develop investigative skills (building towards **PAG12**) students could be asked to evaluate this protocol **before** carrying it out. If they spontaneously identify the need for a control, excellent. If not they could be prompted to propose one (or more). Of course this could be saved for evaluation (step 8) but by then it will be too late to run a useful control. **Activity** 1) Choose three measuring cylinders of appropriate size to suit your cuttings. Label them A, B and C and then fill each with water. 2) Use a blade or scissors to take three cuttings from your plant and place in the measuring cylinders. Try to get these of equal length and stem diameter. **Note:** Each of your cuttings should have leaves at the top. 3) Add more water if necessary to about ¾ depth of cylinder (to a readable volume line) and then place a layer of oil (about 1cm^3) on top of the water using a pipette. 4) Plug the top of the measuring cylinders by wrapping cotton wool around each cutting. Take care not to damage the leaves or stems. 5) Place each of the measuring cylinders on weighing scales and record the mass. 6) Leave on a windowsill for at least 24 hours and then record the mass. 7) Calculate estimated rate of transpiration and evaluate this procedure. 8) Share your results with those of other groups and compare the results for different plant species. **Nuffield Foundation - Transpiration** http://www.nuffieldfoundation.org/practical-biology/estimating-rate-transpiration-plant-cutting Provides ideas for estimating rate of transpiration.	Click here

Thinking Contextually

Activities	Resources
Learner Activity 4 **The mechanism of translocation.** There are two activities here that can be used as an independent summary or homework exercise to check understanding of the concepts. a) Students can use Learner Resource 2 to help write a newspaper 'headliner' about the mechanism of translocation. b) Students can be given a different topic (Learner Resource 3) to discuss regarding the evidence for mass flow. They then report their ideas back to the class with arguments for/against.	Learner Resource 2 Learner Resource 3

Learner Resource 1 Transport in plants

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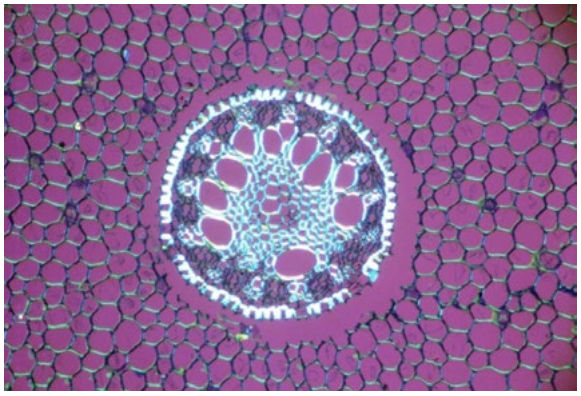
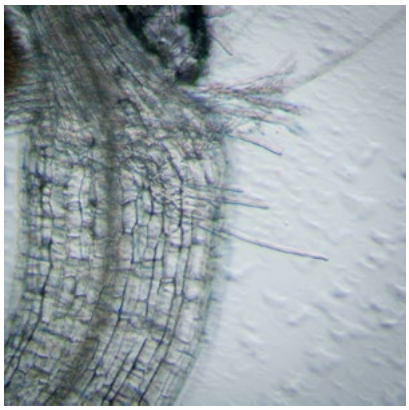


Root micrograph - transverse section of the root of a monocotyledon

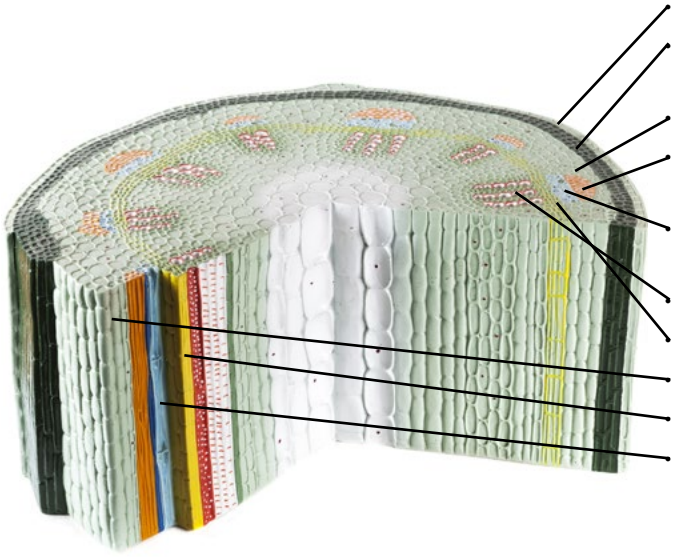
- Xylem vessels appear in section as the large purple areas that surround a central pith.
- Phloem tubes are smaller and are located between the xylem and the endodermis which surrounds the vascular tissues.



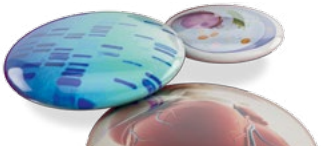
Root micrograph - longitudinal section of the root of a monocotyledon

- Root hairs shown on right.
- Hollow tubes can be seen towards the left representing the vascular bundles.

Stem micrograph - transverse and longitudal section of part of the (young) stem of a dicotyledon



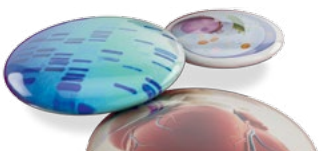
- The outer stem is covered with a thin epidermis
- Under the epidermis is a layer of flexible collenchyma for support
- The cortex and pith is composed of parenchyma tissue
- The vascular bundles have an outer layer of sclerenchyma tissue
- Next is the phloem with sieve tubes, parenchyma and companion cells
- Then the xylem
- In-between the phloem and xylem is the cambium
- At right are large and small parenchyma cells
- Immediately to their left are rows of xylem vessels
- To the left of this is a bundle of phloem fibres sandwiched between two groups of phloem cells.



Annotation

Annotate diagrams using some of these key terms as appropriate

- Epidermis
- Endodermis
- Root hair
- Companion cell
- Phloem (sieve tube element)
- Xylem vessel
- Cambium
- Cortex
- Parenchyma
- Collenchyma
- Vascular bundles



Learner Resource 2 Translocation Story

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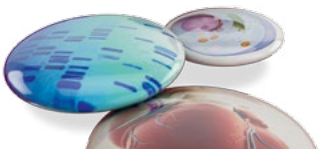
phloem
mass flow
active loading
sink
source
assimilates
active transport
hydrostatic pressure

sieve tube element
xylem vessels
energy
ATP
translocation
transpiration
osmotic pressure gradient

- Design your own newspaper template
- Using the words in the table, write a newspaper article to describe the 'mechanism of translocation'.
- Try to make it sound exciting to engage your reader.
- What evidence do you have?
- What evidence is against your story?



Learner Resource 3

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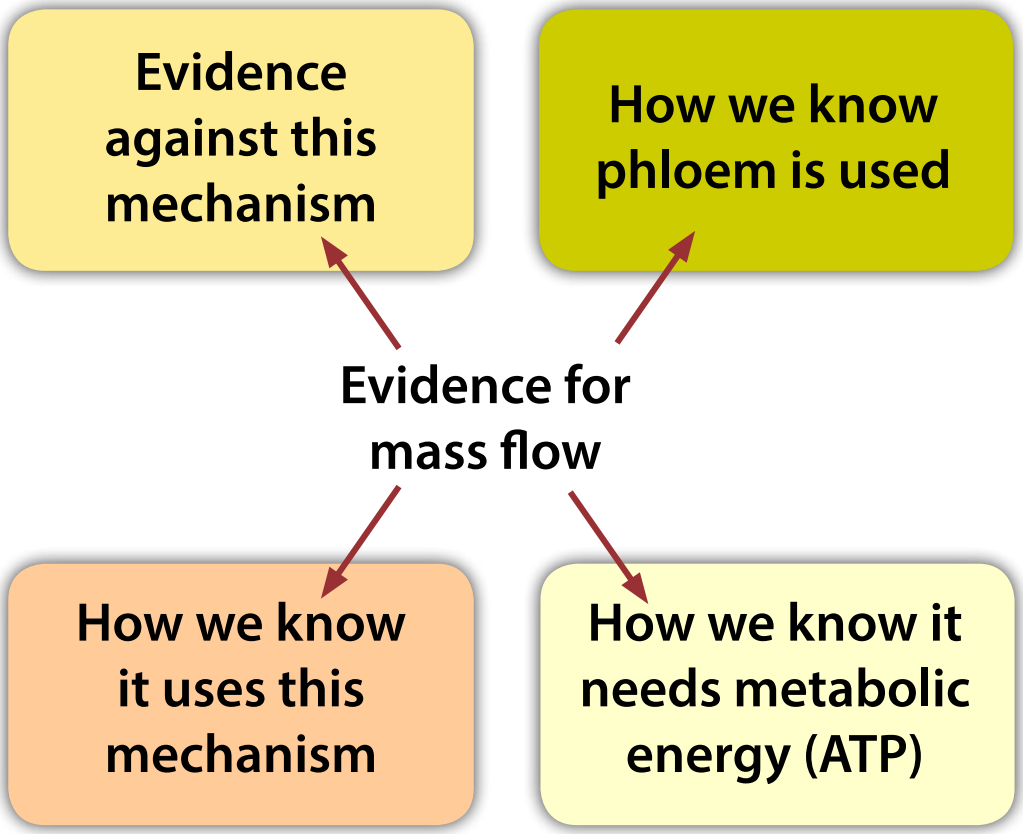


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