Research
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Curricula

How do plants fight against diseases and pests?

Key Stage 4 Biology

Resource 3

2019

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Resource Three Overview

Topic	Plant tissues and their function
GCSE Modules	Cell specialisation, Principles of organisation, Plant tissues, Plant organ system.
Objectives	After completing this resource, you should be able to: ✓ recap how tissues are organised to make up the leaf organ. ✓ explain how stomata controls water status of the plant. ✓ recap xylem and phloem as tissues of the stem. ✓ explain how aphids cause damage to the leaf tissue layers.
Instructions	1. Read the data source 2. Complete the activities 3. Explore the further reading

Resource Three
Data Source

Section A

Plant tissues

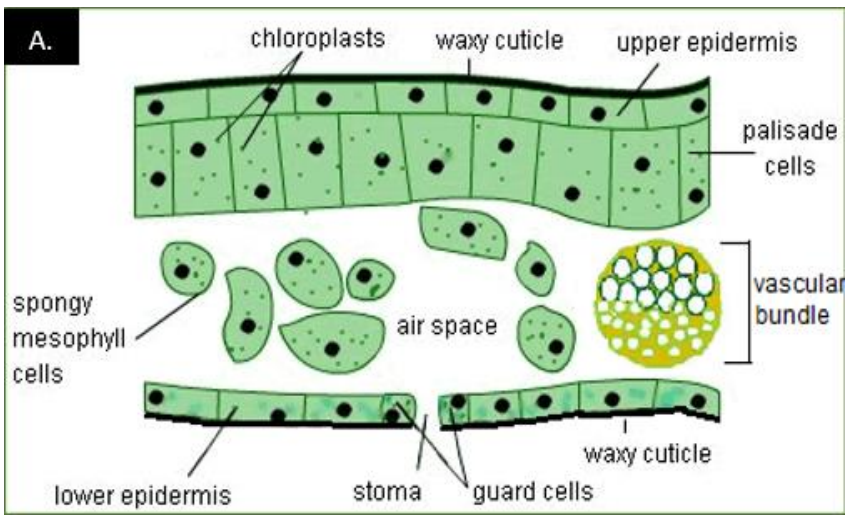
Cells are packed together to form layers. Plant cells may become specialised cells to adapt them for a given function depending on where they are located in the plant. Cells with a common function are grouped together to form tissues. The leaf is an organ made up of several leaf tissue types which are all in some way adapted for photosynthesis, which is the main job of the green leaves of a plant.

On the top and bottom outer surface of a leaf is a waxy cuticle. This is not a layer of cells but a layer of wax which is made by the upper and lower epidermis and secreted to form a new layer. The cuticle wax is waterproof and keeps the water inside the plant, it is also reflective, so it allows light to pass through into the leaf to reach the cells. As it is the outermost layer of the leaf it is the first boundary that insects and pathogens come into contact with and is considered to be a protective layer for the plant. Some plants have waxy surfaces which are slippery so insects may fall off.

The upper and lower epidermis are found on the upper and lower parts of the leaf beneath the secreted wax cuticle. These are the layers you would see if you looked at either of the top or bottom surface of a leaf under a microscope. The two epidermal layers form a barrier to stop pathogen entry on either side of the leaf but again still allow light to pass through for photosynthesis.

Figure 6

Plant cells and tissues

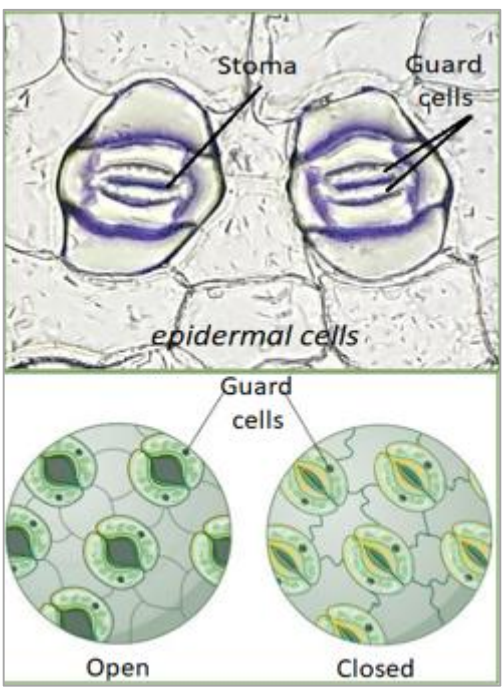


Resource Three
Data Source

Both the upper and lower epidermis contain stomata (singular – stoma) which are small holes which allow CO2 and O2 in and out of the leaf. The lower epidermis has many more stomata than the upper surface and the stomata are surrounded by two guard cells which are specialised cells shaped like kidney beans. The level of water in the guard cells (called turgor) determines whether the guard cells are stretched (full of water which opens the hole) or flaccid (closes the hole). The cell wall of guard cells are thicker on the inside restricting the movement at the stoma and when full of water the outer walls bend outwards because the cell wall is thinner and more flexible. The stomata are used by plants to control the amount of water lost as water vapour to the environment which also drives more water up the stem to the leaves, from the roots. When plants experience drought and the guard cells are flaccid the holes remain closed to conserve water. In the day when plants are photosynthesising the holes are open to allow for gas exchange, and they close at night when there is no light available for photosynthesis.

Figure 7

Stomata



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Data Source

Deep Dive

On the top surface, underneath the upper epidermis are the palisade mesophyll cells. These are stacked upright in a single layer and packed full of chloroplasts to maximize photosynthesis. These cells are positioned to capture the most light and contain more chloroplasts in their cells to convert CO2 to carbohydrates.

In the centre of the leaf are the spongy mesophyll cells which are packed loosely to allow more surface area for CO2 to move into cells and O2 produced by photosynthesis to move out. The air spaces allow gas to flow out of the stomata and into the atmosphere. The centre of the leaf contains vascular tissue composed of xylem and phloem. The vasculature of the leaf ensures that the leaf receives water and nutrients from the roots via the stem, and that the sugars made by the leaf are transported to other tissues of the plant.

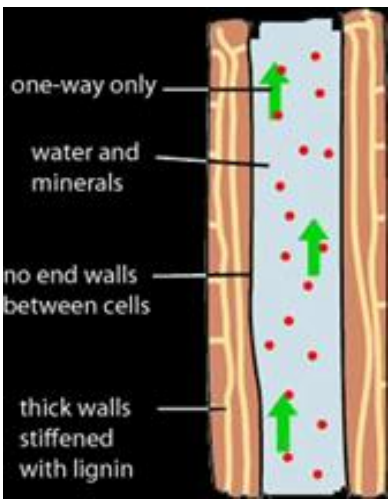
Section B

Xylem and phloem

The stem is an organ specialised for transport. It is made up of xylem and phloem vascular tissue. Xylem vessels transport water and absorbed minerals via the transpiration stream from the roots up the stem and into the veins of the leaf. Transport through the xylem is considered to be one directional starting at the roots and providing a water source to photosynthetic tissue such as leaves. Xylem vessels are slotted on top of each other to form a tube with the ends of walls removed to form a continuous channel. They are adapted to carry large amounts of water and when mature are dead cells.

Figure 8

Xylem



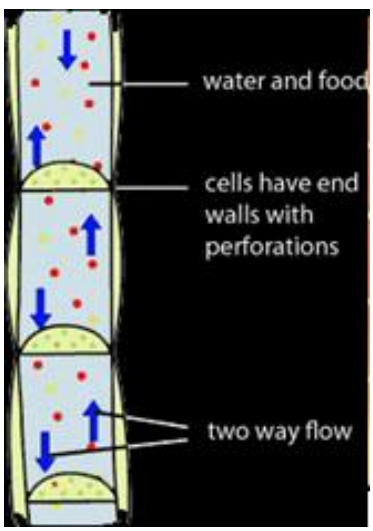
Resource Three
Data Source

Xylem vessels do not contain a nucleus so that they have more cytoplasmic space available to carry water. Like other plant cells they have a primary cell wall, but xylem tissue also has an extra layer called the secondary cell wall. The secondary cell wall is composed of lignin which provides extra thickening and mechanical strength to the stem which has to both support the whole plant upright and has the pressure of carrying large amounts of water. Lignin is what gives tree bark the brown appearance and in trees secondary cell walls are added every year to give the rings which can be seen on a tree stump.

Phloem is arranged next to the xylem and runs inside the stem. Phloem tissue transports dissolved sugars, amino acids and hormones around the plant. Sugars made by the leaf must be transported to other areas of the plant, which may not photosynthesise but still require energy. The plant may also need to transport sugar and amino acids to new leaves, which are growing and not yet able to photosynthesise. Therefore, phloem tissue moves molecules in both directions, both down to the roots and up to new leaves and flowers. This process is called translocation, movement of molecules from where they are made to another tissue, where they are needed for growth and repair. Phloem tissue is living, the cells contain nuclei and have walls between each stacked cell which have holes like a sieve to allow selected molecules to move between cells.

Figure 9

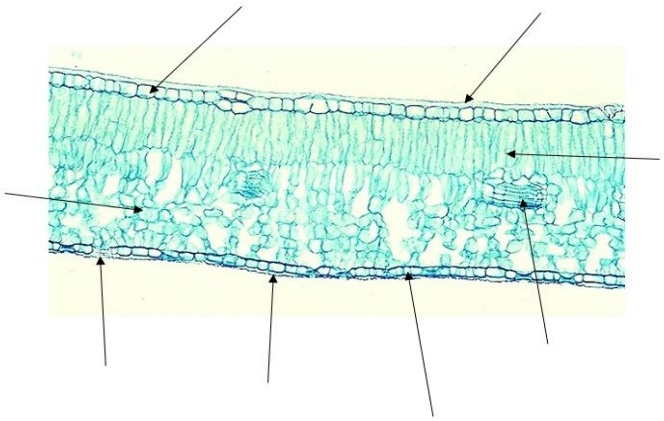
Phloem



Resource Three Activities

Activities

1. Identify and label the cell types and structures in this thin slice through a real leaf.

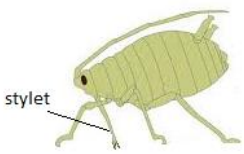


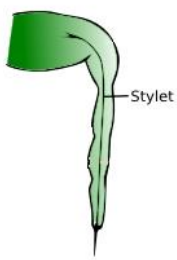
2. Explain the functions of each tissue type and how each of the following tissue types are adapted for their functions:

    - Waxy cuticle –
    - Upper epidermis –
    - Guard cells –
    - Palisade mesophyll cells –
    - Spongy mesophyll cells –

3. Use figure 6 and the text to draw a diagram of the leaf with its different layers using a pencil. Leave some space at the top of your drawing as you will be adding to it.

4. An aphid is a pest which uses its stylet mouthpiece to penetrate a leaf and navigate to the phloem to feed on sugar (see resource 1) . Below is an aphid and an image of its needle-like stylet. Draw an aphid on the surface of your leaf. Draw where its stylet would need to stab into and where it would need to go. Think about the different cell layers it needs to penetrate. You may need to rub out some of your drawing to make way for the insect's stylet.





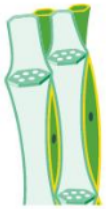
Resource Three Activities

Activities

4. Fill in the gaps in the text below about the xylem and phloem tissues in the stem.

Xylem

The _____ carries water and _____ from the _____ to the leaves and is described as being _____. The water flows via the _____ stream. The cell walls are toughened by _____ and the vessels are _____ and _____ to water.



Phloem

The _____ carries sugars and _____ acids around the plant. The process of moving food substances around the plant is called _____. Phloem vessels are _____ and move substances from tissues which make it called the _____ to tissues that need it, called the _____.

Sink, phloem, dead, living, amino, impermeable, roots, lignin, translocation, minerals, transpiration, source, xylem, uni- directional.

Resource Three
Further Reading

Explore

Independent research

Take a daffodil or white chrysanthemum flower. Place it on a cutting tile and use a scalpel to cut down the middle of the stem longitudinally until you are about 10cm from where the flower starts. (You will need a teacher with you for safety reasons). Stand each half of the stem in a test tube in a rack and secure it with a clamp stand/elastic band. Get two different food colourings (blue and red work well). A type called Kopykake works the best. Add a small amount of colouring to water in each test tube. Observe the flower for the next 24 hours. You will see how the water moves from the bottom of the stem up the xylem to dye the flowers.

- how leaves are adapted for different climates.

https://www.mrgscience.com/yr9-topic-5-plant-structure-and-photosynthesis.html

- revision on xylem and phloem.

https://www.bbc.com/bitesize/guides/zps82hv/revision/1

- quiz about xylem and phloem.

https://www.educationquizzes.com/gcse/biology/unit-3-xylem-and-phloem/

- further information about phloem cells.

https://moodle.beverleyhigh.net/mod/resource/view.php?id=6100

- video about transport in plants

https://www.stem.org.uk/resources/elibrary/resource/35131/plant-transport

www.researchbasedcurricula.com

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