Research
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Curricula

How do plants fight against diseases and pests?

Key Stage 4 Biology

Resource 2

2019

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Resource Two Overview

Topic	How plants respond to attack
GCSE Modules	Eukaryotes and prokaryotes, plant and animal cells, microscopy

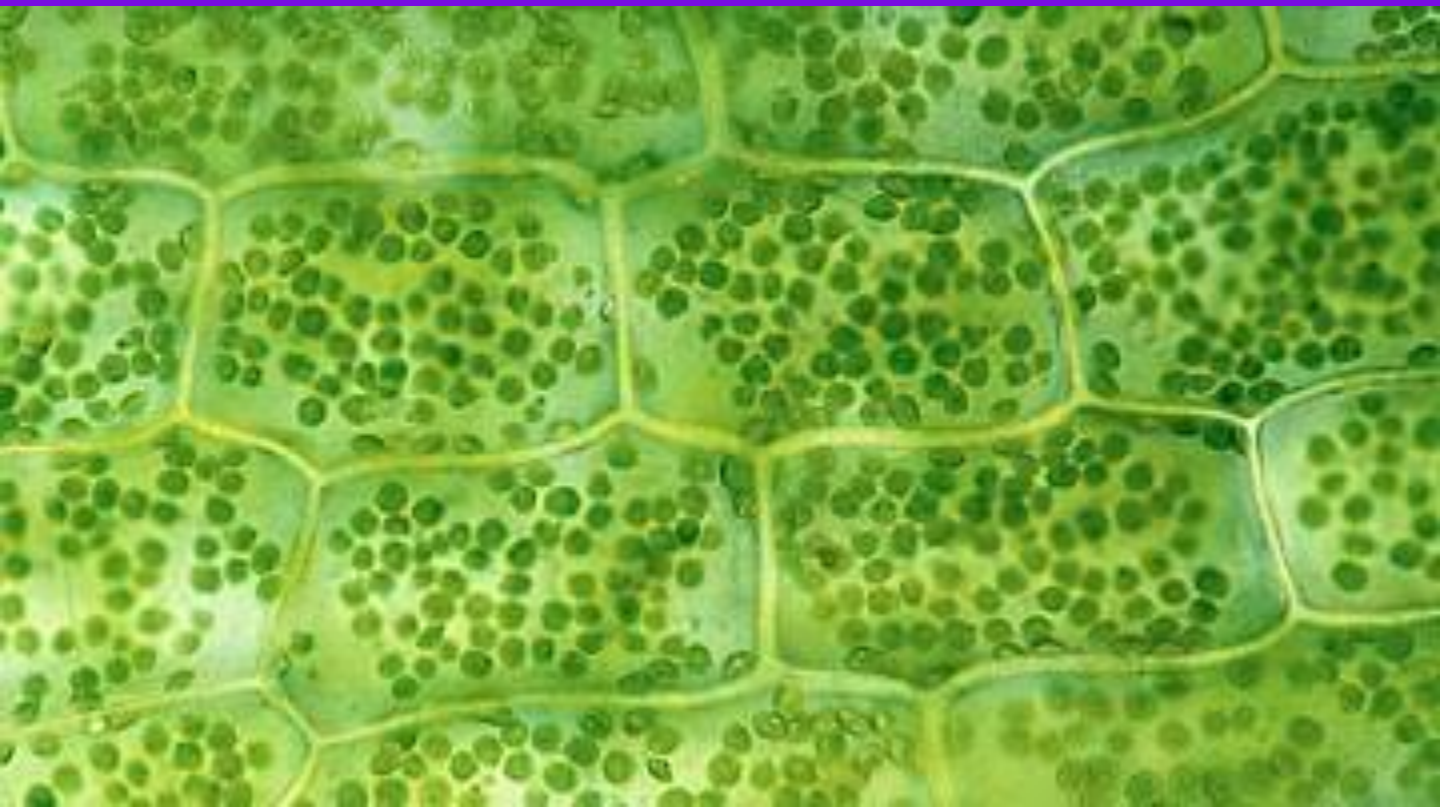
Objectives

After completing this resource, you should be able to:

- ✓ Recognize plant cells under a microscope
- ✓ Recall the organelles that make up a plant cell and what functions they have.
- ✓ Explain how pests and pathogens attack a plant host and how a plant cell generates an immune response

Instructions

1. Read the data source
2. Complete the activities
3. Explore the further reading



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Data Source

Section A

Plant cells

Active Reading

Plants are made up or plant cells. Figure 3 shows leaf cells packed together as seen under a microscope. The cells have fixed shapes and are packed together in lines (called files) which tessellate without overlap. This is quite different to animal cells which are free to move around and vary in their shapes and positions. If you look at the surface of a leaf with a school microscope, you would see the outline of plan cells, marked out by the cell wall, but you would struggle to see finer detail. Plants are eukaryotic organisms because their cells contain a nucleus and they also have organelles which carry out particular jobs. To be able to see the nucleus and organelles you would need to use a higher objective lens or a more powerful microscope.

Figure 3

Plant cells

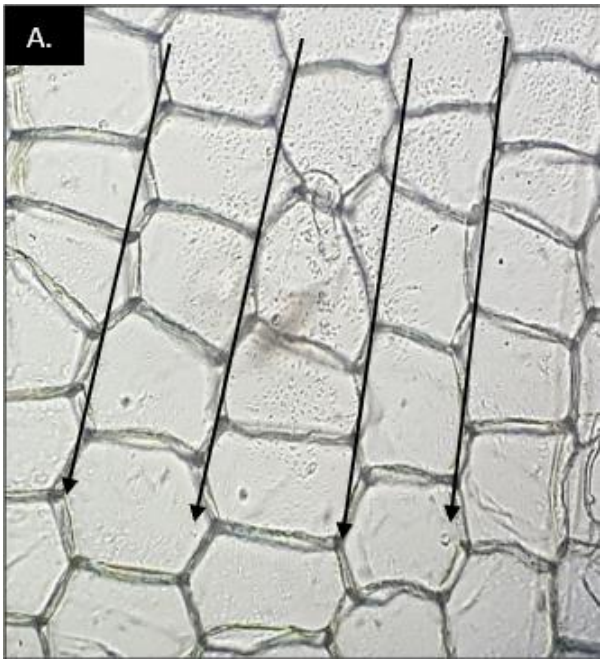

Figure 4 shows the leaf cells using a higher objective lens. The most obvious organelle visible is the spherical green chloroplasts (CH). Chloroplasts are gren because they contain chlorophyll which absorb red and blue light but reflect green light. Chloroplasts carry out photosynthesis in the plant and are therefore not found in animal cells. The cell walls (CW) are also not found in animal cells and mark out the edges of the plant cells. The cell wall is made of tough

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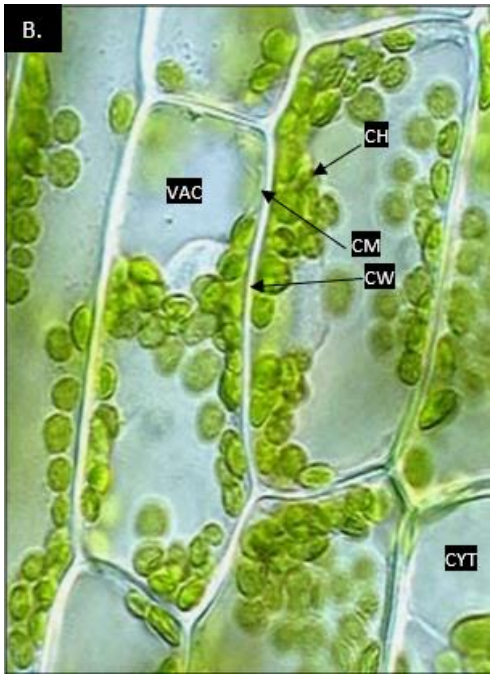
Data Source

cellulose which gives the cells their rigid shapes and allow the cells to contain a high amount of water without bursting. Similar to animal cells, plant cells have a nucleus containing DNA, a cell membrane (CM) to control what enters and leaves the cell, mitochondria to respire, the cytoplasm (CYT) where chemical reactions happen and ribosomes and endoplasmic reticulum which make proteins and fats. Unlike animal cells, plants contain a vacuole (VAC) which is a large central storage compartment separate to the cytoplasm.

Figure 4

Plant cells in detail



Section C

Plant cells and disease

When micro-organisms like the fungus, powdery mildew land on plant cells and penetrate into them they have to pass through barriers including the cell wall and cell membrane. When an aphid uses its stylet to pierce and feed inside cells, it also penetrates through the cell wall and causes cell damage. The cell wall acts as a physical barrier which protects the plant but the penetration peg structure of the fungus or the stylet mouthpart of an aphid can get through some types of plant cells. To get through the cell wall and cell membrane the pest or pathogen wounds the plant cells and leaves them open to other diseases/infections in the same way as in human open skin cuts.

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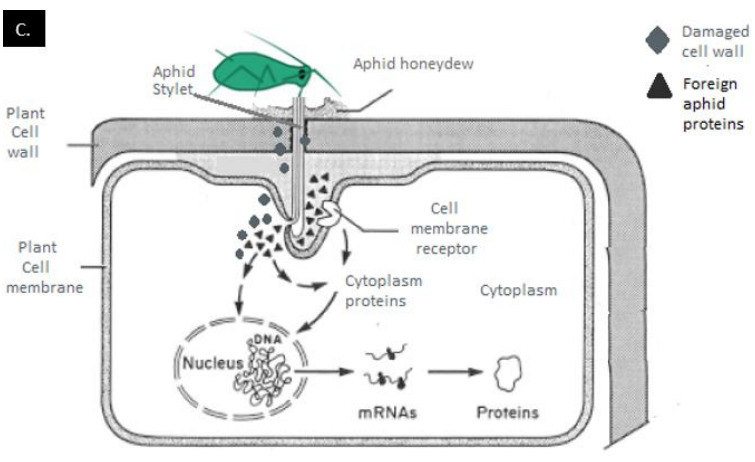
Disease causing organisms can secrete enzymes such as cellulase to breakdown and damage the cellulose plant cell wall. Some organisms can secrete proteins which attach to receptors in the plant cell membrane and trick the plant into letting them inside the cell and then either cause further cell damage or activate the plant cell immune system.

Proteins in the plant cell membrane and cytoplasm can detect when its cell wall has been damaged and plant cells may make more carbohydrates to try rebuild the wounded cell wall. The nucleus of the plant cell can respond quickly by transcribing new genes which are then translated into active proteins to try to fight off the attack. Plant cells may also make and secrete hormones to signal to other cells about the attack, or the cells under attack may make enzymes or release toxic molecules from the vacuole to try to kill the attacking organism.

The chloroplasts and other organelles start to break down and burst open as the plant cells die. The breakdown of chlorophyll in the chloroplasts means that plant cells lose their ability to photosynthesise and lose their green colour and start to undergo the process of senescence, changing colour through to yellow and brown (think of a banana ripening). This colour change is a marker of cell death and scientists think that plants breakdown the compartments in their cells so that the micro-organisms can no longer survive inside them or use the cell for their own gain. This type of plant cell death is called programmed cell death.

Figure 5

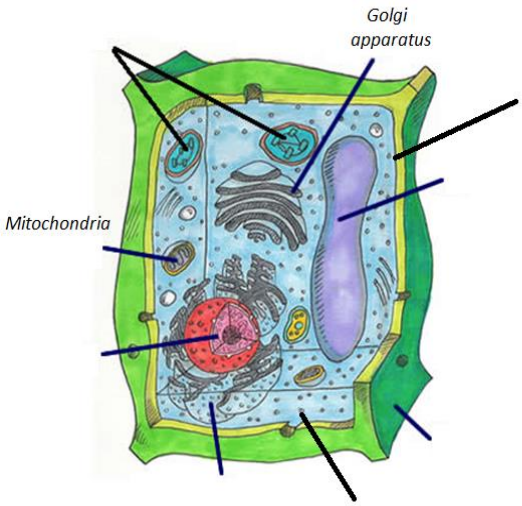
Plant cells and disease



Resource Two Activities

Activities

1. Below is a diagram of a plant cell. Try to fill in the remaining seven unlabelled structures and organelles of the plant cell.



Nucleus *Cell membrane* *Cell wall*

Chloroplasts *Ribosome* *Endoplasmic reticulum*

Vacuole

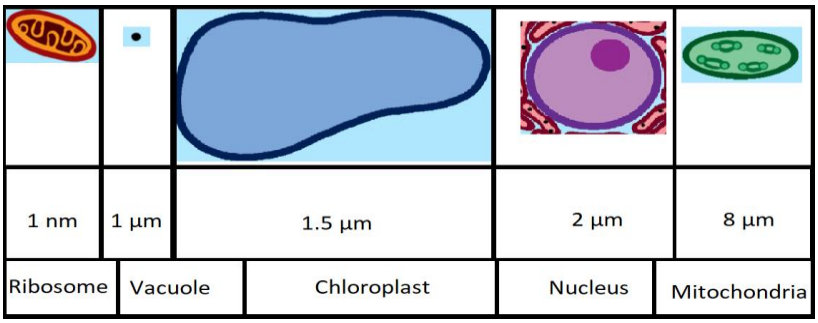
2. Match the organelles to their functions. One has been done for you.

Cell wall	Translates RNA into proteins.
Cell membrane	Site for Photosynthesis. Absorbs light energy to make chemical energy by making carbohydrates.
Cytoplasm	Contains stored chemicals and toxic compounds and releases them when the cell needs them.
Nucleus	Selective membrane which contains receptors and controls what molecules enter and leave the cell.
Chloroplasts	Maintains cell shape, gives strength and ability to hold water. Physical barrier against pathogens.
Vacuole	Contains DNA. Releases genes which encode for antibacterial proteins during pathogen attack.
Ribosomes	Contains proteins which do reactions such as enzymes and other signalling molecules.

Resource Two Activities

Activities

3. It is an important skill in Biology to be able to measure the sizes of cells and structures within them as seen in a microscope. Size and appearance of organelles are two ways we can tell them apart. Arrange and label the following plant organelle names, pictures and sizes from smallest to largest. Remember: 1mm is 1000 times bigger than 1µm. 1µm is 1000 times bigger than 1nm.



4. Using figure 4, explain why you can see plant chloroplasts in a light microscope but cannot see the mitochondria despite them being similar sizes.

5. Use the equation below to work out the actual size of a plant cell. The plant cell in a photograph measures 1.2 mm across. If the magnification in the photograph is x100, what is the actual size of the plant cell?

   Actual size = measured size/magnification

   Actual size = _____ mm

6. Using picture 5 and the text, state five actions a plant cell might do when it recognises it has been eaten by an insect pest or is being attacked by a disease-causing pathogen. Try to include which organelles are involved and what the plant hopes to achieve by these actions.

Resource Two
Further Reading

Explore

- activities to complete about plant cells and their organelles:

https://www.footprints-science.co.uk/index.php?type=Plant%20and%20animal%20cells&section=Section2&info=3

- history of plant disease and how pathogens effect plants:

https://www.britannica.com/science/plant-disease

- How to make your own model plant cell.

https://sciencing.com/make-plant-cell-model-stepbystep-7724993.html

- Look under a microscope at plant cell slides, you can make your own out of an onion, or by cutting a thin slice of a stem and putting it flat on a microscope slide. Try to draw the cells and work out the sizes of the cells you can see using the equation given above using the known magnification on your microscope.

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