Research
Based
Curricula

How do plants fight against diseases and pests?

Key Stage 4 Biology

Model Answers

2019

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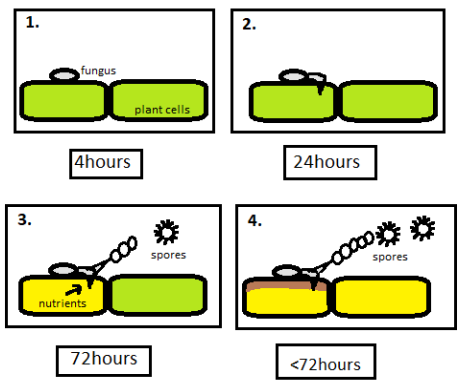
Resource One
Model Answers

Answers

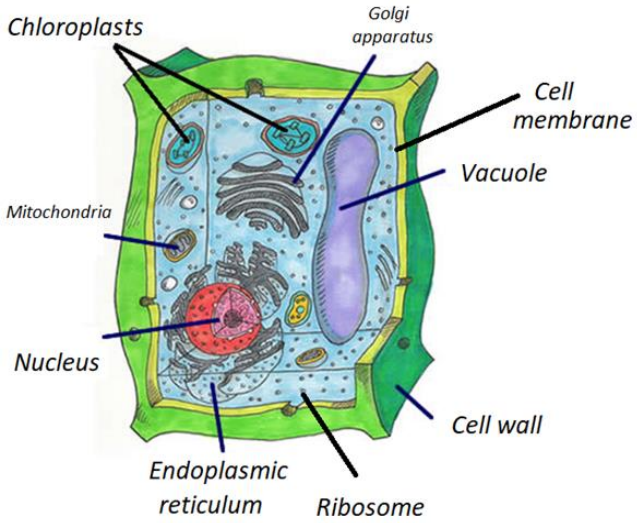
1. Include drawings of: strawberries, cucumbers, courgettes, tomatoes, grapes, wheat, barley, soybeans, onions, apples, pears, melons, raspberries, nectarines, peach, plum, apricots, pumpkin, squash, peas.
2. A.True, B. False, C. False, D. False – only the penetration peg enters into the plant, the rest of the fungus lives on the leaf surface, E. True, F. False, G. False, H. True, I. True, J. True – aphids carry viruses in their saliva and their honeydew attracts ants.
3. Light – easily carried by the wind, Have wings – can be transported far distances to target new plants, Attracted to yellow/green – can detect what is a plant and what is not, Reproduce quickly – ensure that there is a large population very quickly. Camouflage - can be white, green, pink etc depending on the colour of their host plant. Have stylets – which can poke into plant and feed from phloem. Hiding strategies – hide in rolled leaves/under leaves and fruit, Broad host range – attack many plants and are not fussy about their food supply, Lay eggs – can lay eggs in the soil which may be stored over winter and re-infect when Spring/Summer arrives.

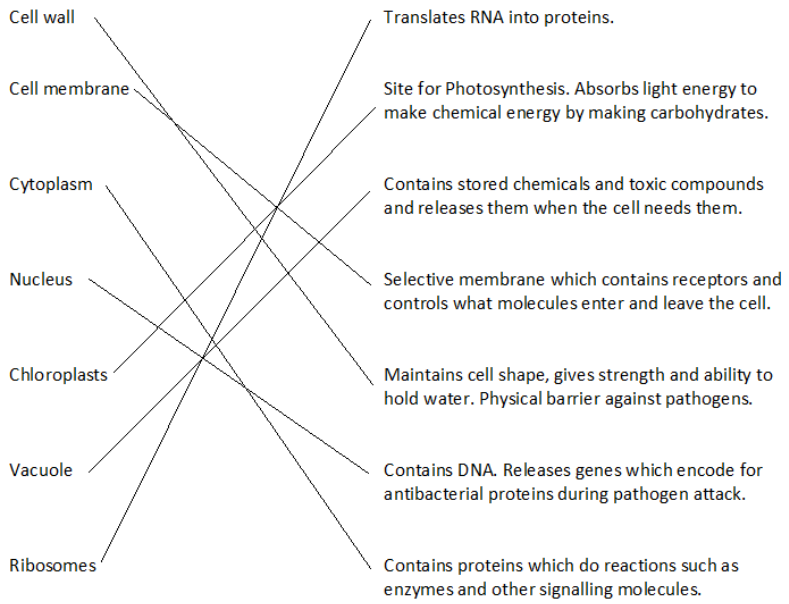


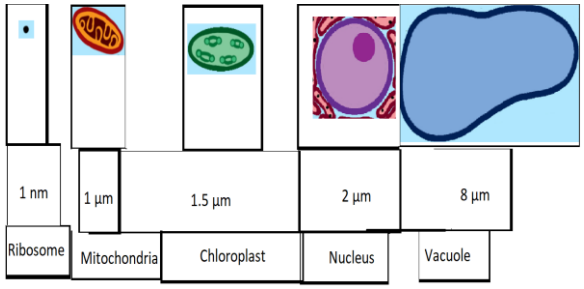
5. The powdery mildew lands on the surface of a healthy plant leaf. It recognises the plant as a plant host and after 24 hours has made a penetration peg structure which penetrates into the upper epidermal layer of cells. By 72 hours the fungus has taken nutrients from the cell it has penetrated. Also at 72hours it uses the nutrients to make spores which are reproductive structures released and carried by air. The importance of spores is to travel and infect new host plants, it is adapted to move easily by air. The cell starts to photosynthesise less and breaks its chlorophyll down to appear yellow. After 72 hours of infection the powdery mildew continues to take nutrients and make even more spores. The cell and other cells of the plant start to die and turn from yellow to brown.

Resource Two
Model Answers

Answers







Resource Two
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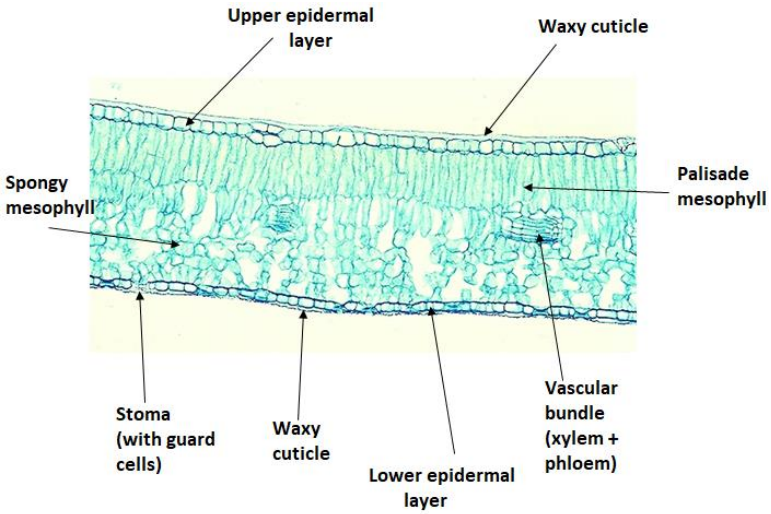
4. The chloroplasts absorb red and blue light because they contain chlorophyll molecules. They reflect green light. You can see them because they are green (fluorescent).
5. 0.012mm (to convert to µm - 0.012mm x1000 = 12µm)
6. The signalling and enzyme molecules in the cell membrane and cytoplasm recognise the cell wall damage. They tell the chloroplast to make carbohydrates and the nucleus makes new enzymes to rebuild the cell wall. The enzymes and signalling molecules in the cytoplasm tell the nucleus to transcribe new genes which are transferred to the ribosomes to make proteins. Proteins might include new enzymes to degrade some of the pathogen/pest molecules. Hormones are also a type of protein made by plant cells which are then secreted out of the cell to target other cells about the attack. Plant cells may make proteins which are toxic to the pest/pathogen or they may release stored toxic molecules from the vacuole and release them to the cytoplasm to target a pathogen inside the cell. Programmed cell death – when a plant decides to breakdown the organelle compartments in the cell, such as the mitrochondria and chloroplasts and starts to breakdown its chlorophyll molecules, this is thought to stop pathogens which live inside the cells being able to survive any longer as the plant cell is officially 'dead'.

Resource Three
Model Answers

Answers

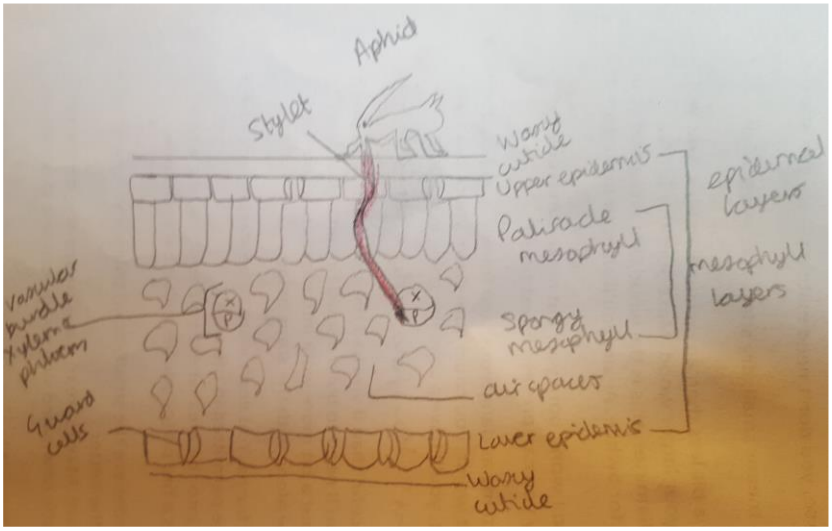


2. Answers:

- Waxy cuticle – Made of wax. Waterproofing, keeps water in. Physical barrier against pests and pathogens. May be thickened and slippy in some plants to make insects fall off. Reflective – lets light through for photosynthesis.
- Upper epidermis – Cells packed together as a layer. Protective layer against pathogen attack. Contain some stomata for gas exchange and transpiration of water.
- Guard cells – Not tissue but cells. Kidney bean shaped with stoma in middle. Cells have different cell wall thickness on inside and outside so outside more flexible and changes shape to reveal stoma. Control CO2 and O2 in and out of the plant leaf for photosynthesis and respiration. shape determined by how much water inside the guard cells (turgor) and controls how much water is lost by evaporation, which also causes cooling of the leaf surface.
- Palisade mesophyll cells – Stacked upright on upper surface of leaf to maximise surface area of light absorbed. Contain lots of chloroplasts for photosynthesis.
- Spongy mesophyll cells – Contain chloroplasts for photosynthesis. Are loosely packed and surrounded by gaps to allow for gas exchange in and out of cells to be lost via stomata.

Resource Three
Model Answers

Answers



The **xylem** carries water and **minerals** from the **roots** to the leaves and is described as being **uni-directional**. The water flows via the **transpiration** stream. The cell walls are toughened by **lignin** and the vessels are **dead** and **impermeable** to water.

The **phloem** carries sugars and **amino** acids around the plant. The process of moving food substances around the plant is called **translocation** Phloem vessels are **living** and move substances from tissues which make it called the **source** to tissues that need it, called the **sink**.

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

Resource Four
Model Answers

Answers

1. Drawing may include: thick waxy cuticle, cell walls and cell membrane of epidermal cells, all closed stomata, less stomata, thick layers of secondary cell walls with lignin, nectar or colourful flowers, digestive fluid to eat insects, hairy (contain trichomes), release toxic or stinging chemicals, spines, thorns, spikey leaves, silicon in leaves, antimicrobial proteins, antiseptic compounds, poisonous chemicals, traps, gases, smelly gases, gases to bring predators near, pigments which look like insect eggs.
2. Digestive fluid to eat insects, silicon in leaves, antimicrobial proteins, antiseptic compounds, poisonous chemicals, releasing gases.

Pest/ pathogen	Problem/ adaptation	Solution
Aphids	Prefer to probe stylet into smooth leaves	Avoid leaves with trichomes or hide on the underside of leaves

Bacteria & Fungi	Small enough to penetrate through stomata	Secrete compounds which force the stomata to stay open or prevent the plant closing them.

Viruses	Tiny pathogens which cannot pass through the cuticle, cell wall or membrane.	Are carried into the plant by insect saliva and wounds

4. Leaf on the right looks healthy and green. Leaf on the left has yellowing and brown discolouration on its surface and is dying. Probably due to pathogen infection.
5. (Answer depends on lesions chosen and scale of print-out). The general answer is plant A has smaller lesion widths and so the average will be smaller than plant B.
6. Plant leaf B is more susceptible to Botrytis. Average lesion sizes are larger on Plant B so the Botrytis has been able to do more damage. Plant B leaf may have less defences than the leaf from plant A for example less trichomes, thinner cell walls, cuticle. Any defence from text that depicts there is less defence in plant B relative to plant A.
7. Plant leaf A is less susceptible (more resistant) - it doesn't have as much damage on the leaf and lesions are smaller. Average lesion size of the 3 counts is smaller than plant B. Any named example of a plant defence, special recognition if the student chooses something specific to tomatoes such as more trichomes, more sticky substances released, stronger smelling gases etc.

Resource Five
Model Answers

Answers

1. Climate changes causes more unpredictability in weather: more drought periods, more rainfall (flooding periods), hotter and longer heatwaves. Any discussion of how water or temperature might effect photosynthesis or transpiration (water loss). More specific discussion about how higher temperatures and humidity can increase success rates and spread of pathogens and pests. Use of example of powdery mildew germination and making spores, use of example of aphid requiring frost period. Mention of the spread of pathogens/pests to new areas because of more suited climates.

Aphids | Insecticide

Japanese knotweed | Herbicide

Slug | Molluscicide

Powdery mildew | Fungicide

Xanthamonas | Bactericide

Tobacco mosaic virus | Virucide

Resource Five
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Answers

3a. get to the leaf: From spray bottle, sprayed through air, some lost as the water evaporates (or vapourises), more gets to leaf on dry, still day. Droplets lost by wind and rain causes it to run off leaf. Some droplets lost to environment.

3b. get into phloem: Leaf surface, penetrates through waxy cuticle, penetrates into cell walls or cell membrane of upper epidermal layer, penetrates through palisade mesophyll, moves through spongy mesophyll or air spaces to reach phloem in vascular bundle.

4.A farmer would not spray because more droplets wont reach the leaf on a wet and windy day. More chemical will be wasted, more chemical would be lost to the environment. Wet leaves cause the droplets to run-off the leaf and stops them sticking, wind causes the spray to miss the target and carries droplets elsewhere.

5. An adjuvant helps the pesticide better reach its target location. It may help it stick to a leaf for longer, may help it spread across a leaf surface to give a better surface area of coverage, it may help it retain water and stay wet for longer, it may help it penetrate into a leaf quicker.

6. Biological control is the use of live organisms to aid in plant protection/help deal with pests/pathogens. This may include any prey/predator relationship of the herbivore (primary consumer) of the plant (producer). It may include examples of the Bacillus bacteria family or the Trichoderma fungi family.

7a. Before: 2 black insects. After: 1 black insect.

7b. Before: 19 white insects. After: 2 white insects.

7c. The insecticide used controlled the white insects best. It was able to kill more white insects, it killed 50% of the black insect population but more than 50% of the white insect population. 50% of the black insect population still remains on the plant. There was a smaller number of black insects and only 1 was killed.

7d. The insecticide may not be the correct type of insecticide for the black insects. The remaining black and white insects that survived have better resistance to the insecticide. They have evolved a particular defence to stop being killed by the particular insecticide.

7e. A different insecticide, a repeated spray, or any form of biological control mentioned in the text. Introduce a predator, introduce a fungus or bacteria that might kill the insects.

Resource Six
Model Answers

Answers

1. Hydrophobic – water hating or repels water, in other words it is oil-loving. Hydrophilic – water loving or attracts water, in other words oil hating.
2. The waxy cuticle because it is made of wax, a lipid. The cell membrane because it is made of lipid (hydrophobic) tails.
3. They are succulent plants which means they have adapted to have a thicker waxy cuticle to stop water loss through transpiration in hot, dry climates. The thick waxy layer repels water forming a separate water layer on top of the leaves.
4. They can tell us how warm/cold the droplet is and whether it is there or not.
5. Fungicide because powdery mildew is a fungus.
6. We don't know how much of the droplet has evaporated away and how much has penetrated through to the leaf layers. We only know if it's on the surface or not.
7. A fluorescent molecule allows scientists to visualise whether a dye or a molecule is there or not because it reflects a specific wavelength to give us a colour we can see.
8. Adjuvant B.
9. Adjuvant B because there is more yellow dye in the mesophyll and veins of the leaf. The phloem is stained more yellow with adjuvant B than with adjuvant D which only appears white/faint yellow.
10. You could count how many aphids were on the plant before and after the treatment and work out what percentage of the population had been killed. You could see whether these is less damage on the leaf which had been treated with the insecticide/adjuvant B compared to a leaf of a plant which had not been treated with anything.

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