

# Plant Diseases and Defences

## Mark Scheme



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1. Plants face constant threats from infection by pathogens and damage from herbivores. Circle the letter of the correct answer for each of the following questions regarding plant diseases and defences.

- a) Which of the following is an example of a **physical** defence mechanism in plants against pathogens?

|                                        |                      |
|----------------------------------------|----------------------|
| <b>C – is the only correct answer.</b> | <b>1 mark</b>        |
|                                        | <b>Total: 1 mark</b> |

- b) The figure below shows a rose leaf with symptoms of a common plant disease.



Which of the following is responsible for these symptoms?

|                                        |                      |
|----------------------------------------|----------------------|
| <b>B – is the only correct answer.</b> | <b>1 mark</b>        |
|                                        | <b>Total: 1 mark</b> |

- c) A gardener observes that the older leaves of their tomato plants are turning yellow between the veins, while the veins themselves remain green. This is a symptom of a mineral deficiency.

Which of the following mineral ions is most likely deficient in these tomato plants?

|                                        |                      |
|----------------------------------------|----------------------|
| <b>D – is the only correct answer.</b> | <b>1 mark</b>        |
|                                        | <b>Total: 1 mark</b> |

- d) Which of the following is an example of a **chemical** defence used by plants to deter herbivores?

|                                        |                      |
|----------------------------------------|----------------------|
| <b>C – is the only correct answer.</b> | <b>1 mark</b>        |
|                                        | <b>Total: 1 mark</b> |

(Total for Question 1 is 4 marks)

2. An aphid pierces plant tissue with its mouthpart to consume plant sap.

Aphids are capable of transferring plant pathogens from plant to plant when they feed.

- a) Describe the physical barriers a virus has to get through in a leaf when an aphid takes a bite?

|                                                             |                       |
|-------------------------------------------------------------|-----------------------|
| A description to include any <b>three</b> of the following: |                       |
| Waxy cuticle                                                | 1 mark                |
| Epidermis / epidermal layer                                 | 1 mark                |
| Cell wall(s) (of penetrated cells)                          | 1 mark                |
|                                                             | <b>Total: 3 marks</b> |

- b) Plants also have chemical defences against pathogens.

Describe **one** example of a chemical defence a plant might use against aphids and explain how this defence works.

|                                                                                                                                                                                                                                                      |                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>One mark for naming a valid chemical defence type or specific chemical:</b>                                                                                                                                                                       |                       |
| Alkaloids<br><b>Accept:</b> Poisons / toxins.<br><br>Nicotine / caffeine<br><b>Accept:</b> Insecticides produced by the plant.<br><br>Tannins.<br><b>Accept:</b> Bitter tasting chemicals / substances.                                              | 1 mark                |
| <b>One mark for explaining the effect on the aphid:</b>                                                                                                                                                                                              |                       |
| Poisonous / toxic to the aphid.<br>Acts as a deterrent / puts aphid off feeding<br>Affects the nervous system<br>Reduces digestibility / inhibits enzymes<br>Repels the aphid                                                                        | 1 mark                |
| <b>One mark for explaining how the effect works or the consequence:</b>                                                                                                                                                                              |                       |
| Kills the aphid<br>Causes paralysis / stops muscles working<br>Stops the aphid feeding / damages mouthparts<br>Aphid cannot get enough nutrients / energy / protein (linked to digestibility)<br>Damages aphid cells / tissues / disrupts metabolism | 1 mark                |
|                                                                                                                                                                                                                                                      | <b>Total: 3 marks</b> |

- c) If the gardener suspects their plants have a fungal disease, suggest one method they could use to try and prevent its spread to other plants.

|                                                                      |                      |
|----------------------------------------------------------------------|----------------------|
| Any <b>one</b> of the following:                                     |                      |
| Remove / dig up / take away infected plant(s) / parts (and destroy). | 1 mark               |
| Burn infected plant(s) / parts                                       | 1 mark               |
| Use a fungicide.                                                     | 1 mark               |
| Clean / sterilise / disinfect tools (between plants)                 | 1 mark               |
|                                                                      | <b>Total: 1 mark</b> |

(Total for Question 2 is 7 marks)

3. A gardener observes several of their rose bushes showing unusual symptoms. Some leaves have developed black spots surrounded by yellowing, while other bushes have stems with swollen, distorted growths.

- a) State **two** different visual signs of plant disease shown by the gardener's rose bushes.

|                                                                                          |                       |
|------------------------------------------------------------------------------------------|-----------------------|
| A description to include any <b>two</b> of the following:                                |                       |
| Black spots (on leaves).                                                                 | 1 mark                |
| Yellowing / yellow leaves / leaves turning yellow (around spots or generally described). | 1 mark                |
| Swollen growths (on stems)                                                               | 1 mark                |
| Distorted growths (on stems)                                                             | 1 mark                |
|                                                                                          | <b>Total: 2 marks</b> |

- b) Suggest **two** different causes, other than a lack of nutrients, that could be responsible for these visual signs of disease in the rose bushes.

|                                                           |                       |
|-----------------------------------------------------------|-----------------------|
| A description to include any <b>two</b> of the following: |                       |
| Fungal infection / Fungi                                  | 1 mark                |
| Bacterial infection / Bacteria                            | 1 mark                |
| Viral infection / Virus                                   | 1 mark                |
| Insect infestation / Pests / named insect                 | 1 mark                |
|                                                           | <b>Total: 2 marks</b> |

- c) The gardener wants to identify the specific diseases affecting their rose bushes so they can take appropriate action.

Describe three methods the gardener could use to help them identify the causes of these symptoms.

|                                                                                                              |                       |
|--------------------------------------------------------------------------------------------------------------|-----------------------|
| A description to include any <b>three</b> of the following:                                                  |                       |
| Look up symptoms or pictures in a gardening book / manual / website / online resource / plant disease guide. | 1 mark                |
| Use a plant disease identification app / website (where symptoms/photos can be uploaded/compared).           | 1 mark                |
| Send a sample (of affected leaf/stem) for laboratory testing / analysis.                                     | 1 mark                |
| Consult / ask an expert / professional                                                                       | 1 mark                |
|                                                                                                              | <b>Total: 3 marks</b> |

(Total for Question 3 is 7 marks)

4. A student is investigating the effect of different mineral deficiencies on the growth of young tomato plants.

Describe the expected visual symptoms of the plants in Group B and Group C, and explain how the lack of magnesium and nitrate ions leads to these symptoms.

| Marking guidance |       |                                                                                                                                                                                                                                                                                                                                                                       |
|------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level            | Marks | Descriptor                                                                                                                                                                                                                                                                                                                                                            |
| Level 1          | 1 - 2 | At least one relevant symptom for either Group B or Group C is described. OR - A simple statement about the role of at least one ion is made (e.g., Mg for chlorophyll, nitrates for growth)                                                                                                                                                                          |
| Level 2          | 3 - 4 | Symptoms for both Group B and Group C are described, possibly with less clarity or accuracy for one. OR Symptoms for one group are described accurately. - An explanation is provided for at least one deficiency, linking the ion's role to the symptom with some biological reasoning.                                                                              |
| Level 3          | 5 - 6 | Symptoms for both Group B (magnesium deficiency) and Group C (nitrate deficiency) are clearly and accurately described. - Explanations for both deficiencies are provided, clearly linking the role of the specific ion (Mg and Nitrate/N) to the observed symptom using correct biological reasoning (chlorophyll for Mg, amino acids/proteins/growth for nitrates). |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>Indicative content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                       |
| <p><b>Group B (Magnesium Deficiency)</b></p> <p><b>Symptom:</b></p> <ul style="list-style-type: none"> <li>Leaves turn yellow / pale green (especially older leaves or between veins).</li> <li>Chlorosis / lack of green colour.</li> </ul> <p><b>Explanation:</b></p> <ul style="list-style-type: none"> <li>Magnesium (ions) are needed to make / are part of the chlorophyll molecule.</li> <li>Chlorophyll is the green pigment in leaves.</li> <li>Chlorophyll absorbs light energy for photosynthesis.</li> <li>Lack of magnesium means less / no chlorophyll can be made.</li> <li>Therefore, the green colour fades / leaves appear yellow.</li> </ul> <p><b>Group C (Nitrate Deficiency)</b></p> <p><b>Symptom:</b></p> <ul style="list-style-type: none"> <li>Stunted growth / poor growth / small plant / small leaves.</li> <li>Leaves may also appear pale green / yellowish (overall, not just spotting like Mg).</li> </ul> <p><b>Explanation:</b></p> <ul style="list-style-type: none"> <li>Nitrate (ions) are needed as a source of nitrogen.</li> <li>Nitrogen is needed to make amino acids.</li> <li>Amino acids are used to make / synthesise proteins.</li> <li>Proteins are essential for growth (e.g., making new cells, enzymes).</li> <li>Lack of nitrates means lack of nitrogen.</li> <li>Therefore, less / no protein synthesis occurs.</li> <li>Resulting in poor / stunted growth.</li> </ul> <p>(Allow: Nitrogen is also needed for DNA / chlorophyll synthesis - less common link at GCSE but valid).</p> |                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Total: 6 marks</b> |

(Total for Question 4 is 6 marks)

5. Tobacco Mosaic Virus (TMV) is a common plant pathogen that affects many species, including tomatoes and tobacco plants.

- a) Describe the main visual symptom of Tobacco Mosaic Virus (TMV) infection visible in the figure above.

|                                                                       |                       |
|-----------------------------------------------------------------------|-----------------------|
| A description to include any <b>two</b> of the following:             |                       |
| Mosaic pattern (of discolouration / yellowing / light and dark green) | 1 mark                |
| Yellow / light green patches / spots / areas (on the leaf).           | 1 mark                |
| <b>Accept:</b> Discoloured patches / spots / areas / blotches.        |                       |
| Areas of chlorosis / lack of green colour (in a mosaic pattern)       | 1 mark                |
|                                                                       | <b>Total: 2 marks</b> |

- b) Explain how a virus, such as TMV, can cause disease in a plant.

|                                                                                                                       |                       |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------|
| An explanation to include any <b>three</b> of the following:                                                          |                       |
| Virus / TMV enters / infects (plant) cells                                                                            | 1 mark                |
| Injects / inserts its genetic material / RNA / DNA (into the host cell)                                               | 1 mark                |
| Uses the host cell's machinery / ribosomes / enzymes / resources / metabolism                                         | 1 mark                |
| To replicate / reproduce / make copies of itself / make more viruses.                                                 | 1 mark                |
| New viruses are assembled / formed.                                                                                   | 1 mark                |
| This damages / destroys / kills the host cell(s) OR causes cell(s) to burst / lyse.                                   | 1 mark                |
| Cell damage prevents / reduces normal processes (e.g., photosynthesis) OR Cell damage leads to the observed symptoms. | 1 mark                |
|                                                                                                                       | <b>Total: 3 marks</b> |

- c) Suggest **two** ways that Tobacco Mosaic Virus could spread from one plant to another.

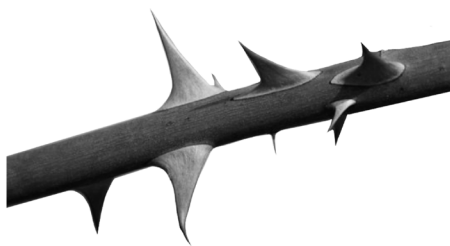
|                                                                                                            |                       |
|------------------------------------------------------------------------------------------------------------|-----------------------|
| A description to include any <b>two different ways</b> from:                                               |                       |
| Direct contact (between infected and healthy plants / leaves)                                              | 1 mark                |
| Via contaminated tools (e.g., secateurs, knives, equipment used on infected then healthy plant)            | 1 mark                |
| Via insect vectors / named vector (e.g., aphids, although less common for TMV primary spread than contact) | 1 mark                |
| From contaminated soil / plant debris (containing the virus)                                               | 1 mark                |
| Via contaminated hands / handling (e.g., touching infected then healthy plant)                             | 1 mark                |
|                                                                                                            | <b>Total: 2 marks</b> |

- d) Describe **one** method a gardener could use to help prevent the spread of TMV in their greenhouse.

|                                                                        |                      |
|------------------------------------------------------------------------|----------------------|
| A description to include any <b>one</b> of the following:              |                      |
| Remove / destroy infected plants (promptly).                           | 1 mark               |
| Wash hands (thoroughly / with soap) between handling different plants. | 1 mark               |
| Clean / disinfect / sterilise tools (between plants / after use).      | 1 mark               |
| Control pests / insects / vectors (that might spread the virus).       | 1 mark               |
| Ensure adequate spacing between plants.                                | 1 mark               |
| Avoid touching healthy plants after touching infected ones.            | 1 mark               |
|                                                                        | <b>Total: 1 mark</b> |

(Total for Question 5 is 8 marks)

6. The figure below shows thorns on the stem of a plant.



a) Describe how a plant can use thorns to protect itself from herbivores and state why this is a benefit to the plant.

|                                                                                                                                                                                                                                                                                                          |                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>Mark Point 1: How thorns protect</b>                                                                                                                                                                                                                                                                  |                       |
| <ul style="list-style-type: none"> <li>Thorns deter / stop herbivores / animals (from eating the plant).</li> <li>Linked to idea that they are sharp / pointed / spikey / cause pain / hurt / injure the animal.</li> </ul>                                                                              | 1 mark                |
| <b>Mark Point 2: Why this is a benefit</b>                                                                                                                                                                                                                                                               |                       |
| <ul style="list-style-type: none"> <li>Prevents / reduces damage to the plant (leaves / stems / flowers).</li> <li>Increases chance of survival.</li> <li>Allows plant to photosynthesise (more effectively).</li> <li>Increases chance of reproduction / allows flowering / seed production.</li> </ul> | 1 mark                |
|                                                                                                                                                                                                                                                                                                          | <b>Total: 2 marks</b> |

b) Explain how a fungus, such as the one that causes black spot, obtains nutrients from a plant?

|                                                                                                                 |                       |
|-----------------------------------------------------------------------------------------------------------------|-----------------------|
| An explanation to include any <b>two</b> of the following:                                                      |                       |
| Fungus grows hyphae / mycelium (into / onto / among plant tissues / cells)                                      | 1 mark                |
| Secretes / releases enzymes (onto plant tissue / cells / food source)                                           | 1 mark                |
| Enzymes digest / break down (plant) cells / tissues / large molecules / organic matter (into smaller molecules) | 1 mark                |
| Fungus absorbs the (digested / small / soluble) nutrients / molecules / food (through hyphae / cell walls)      | 1 mark                |
|                                                                                                                 | <b>Total: 2 marks</b> |

c) Scientists can use monoclonal antibodies to identify the presence of specific plant diseases.

Outline how monoclonal antibodies can be used in a test to detect the presence of a particular pathogen in a plant sample.

|                                                                                                                                                                  |                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A description to include any <b>three</b> of the following:                                                                                                      |                       |
| Monoclonal antibodies are specific to / bind to / recognise a particular / specific antigen / protein / molecule (on the pathogen)                               | 1 mark                |
| Plant sample / extract is exposed to / mixed with the monoclonal antibodies.                                                                                     | 1 mark                |
| Binding occurs only if the specific pathogen / antigen is present (in the sample)                                                                                | 1 mark                |
| The monoclonal antibody is linked / attached to a label / marker / indicator / enzyme / fluorescent dye                                                          | 1 mark                |
| A detectable change / signal (e.g., colour change / fluorescence / light emitted) is produced if the monoclonal antibody has bound / if the pathogen is present. | 1 mark                |
|                                                                                                                                                                  | <b>Total: 3 marks</b> |

(Total for Question 6 is 12 marks)

d) Describe the main stages involved in the production of monoclonal antibodies.

| Marking guidance |       |                                                                                                                                                                                                                                                                                                                                                                |
|------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level            | Marks | Descriptor                                                                                                                                                                                                                                                                                                                                                     |
| Level 1          | 1 - 2 | A simple description identifying some relevant points (e.g., inject mouse, get antibodies, cells are mixed). The steps may be isolated or not in a logical sequence. Limited or incorrect use of key scientific terminology.                                                                                                                                   |
| Level 2          | 3 - 4 | A <b>generally correct</b> description identifying <b>several key steps</b> in the process. Steps are <b>mainly in sequence</b> and logically linked, but the description may lack some detail or clarity in places.                                                                                                                                           |
| Level 3          | 5     | A clear and detailed description of the key steps involved in monoclonal antibody production, presented in a logical sequence. Appropriate scientific terminology (e.g., antigen, lymphocyte, myeloma/tumour cell, fuse, hybridoma, clone, monoclonal antibody) is used accurately throughout. Shows clear linkage between the diagram and recalled knowledge. |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>Indicative content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |
| <ul style="list-style-type: none"> <li>• Mouse/animal injected with antigen/pathogen.</li> <li>• Stimulates lymphocytes / B-cells (to produce antibodies).</li> <li>• Lymphocytes / B-cells are isolated/extracted (from mouse/spleen).</li> <li>• Lymphocytes are fused with tumour cells / myeloma cells.</li> <li>• This produces hybridoma cells.</li> <li>• Hybridoma cells are screened / selected (for desired antibody production).</li> <li>• Selected hybridoma cells are cloned / cultured / allowed to divide.</li> <li>• Large quantities of (identical) monoclonal antibodies are produced/collected.</li> </ul> |                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Total: 5 marks</b> |

(Total for Question 6 is 12 marks)

7. Plants have evolved various structural features to help them survive.  
Some of these features, known as mechanical adaptations, provide protection against herbivores.  
The figure below shows a cactus.

a) Explain how the sharp structures found on the surface of a cactus can act as a defence against being eaten by herbivores.

|                                                                                                                                                                                                              |                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>Mark Point 1:</b> Physical effect on herbivore – max 1 mark from this section.                                                                                                                            |                       |
| <ul style="list-style-type: none"> <li>• Sharp structures / spines / needles are sharp / pointed / spikey.</li> <li>• and cause pain / hurt / injury / damage (to the herbivore / animal / mouth)</li> </ul> | <b>1 mark</b>         |
| <b>Mark Point 2:</b> Consequence for herbivore behaviour / plant protection – max 1 mark from this section.                                                                                                  |                       |
| This deters / discourages / stops herbivores / animals (from eating the plant).                                                                                                                              | <b>1 mark</b>         |
| So the plant is less likely to be eaten / avoids being eaten.                                                                                                                                                | <b>1 mark</b>         |
|                                                                                                                                                                                                              | <b>Total: 2 marks</b> |

- b) Some plants have leaves that exhibit rapid movement when touched, such as drooping or curling.

Explain how this response could be beneficial to the plant.

|                                                                                                                                                                                                                                                                                                                                                                                                     |                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>Mark Point 1: Effect of movement - max 1 mark from this section.</b>                                                                                                                                                                                                                                                                                                                             |                       |
| <ul style="list-style-type: none"> <li>• Movement may dislodge / knock off insects / small pests / herbivores.</li> <li>• Movement may startle / frighten / deter a herbivore / animal / insect.</li> <li>• Drooping / curling makes the leaf look smaller / less appealing / less nutritious / wilted / dead.</li> <li>• Reduces the surface area (available for feeding / landing on).</li> </ul> | 1 mark                |
| <b>Point 2: Resulting benefit / consequence - max 1 mark from this section.</b>                                                                                                                                                                                                                                                                                                                     |                       |
| <ul style="list-style-type: none"> <li>• So prevents / reduces feeding / damage (by the herbivore / pest).</li> <li>• So the herbivore / pest moves away / leaves the plant</li> <li>• (Therefore) increases plant's chance of survival / growth / photosynthesis / reproduction (linked to reduced damage/feeding).</li> </ul>                                                                     | 1 mark                |
|                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Total: 2 marks</b> |

- c) Give **one** example of how a plant uses mimicry as a defence mechanism against herbivores and describe how this adaptation might protect the plant.

|                                                                                                                                                                                                                                       |                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>Mark Point 1: Example of mimicry</b>                                                                                                                                                                                               |                       |
| Plant mimics the appearance of a poisonous / thorny / inedible plant nearby.<br>Plant has patterns that mimic existing insect damage / infestation.<br>Passion flower (leaves) have structures that look like / mimic butterfly eggs. | 1 mark                |
| <b>Mark Point 2: How it protects</b>                                                                                                                                                                                                  | 1 mark                |
| Accept any answer where the mimicry deters either insects or herbivores from damaging the plant.                                                                                                                                      | 1 mark                |
|                                                                                                                                                                                                                                       | <b>Total: 2 marks</b> |

(Total for Question 7 is 6 marks)