**Model Answers: Hard**

1a

a) i) Two features visible in Fig. 1 that enables the Venus flytrap to gain nitrogen compounds are…

- Sensory hairs / hairs to sense movement (of insects); [1 mark]
- Stiff spines/hairs (along edges of the leaf) that can interlock / that trap prey/insects inside leaf; [1 mark]

a) ii) One other feature that is not visible in Fig. 1 that aid the plant in the same process is…

- Red leaves / glands that produce/secrete nectar; [1 mark]
- To attract insects/prey; [1 mark]

**OR**

- Glands that produce / the ability to produce (digestive) enzymes; [1 mark]
- To digest / break down the bodies of insects/prey **OR** to release nitrates from the bodies of prey; [1 mark]

**[Total: 4 marks]**

1b

b) i) At threshold A in Fig. 2 the following occurs…

- The leaves close / form a trap; [1 mark]

b) ii) This occurs because…

Any **three** of the following:

- Two (sensory) hairs are stimulated / a hair is stimulated twice; [1 mark]
- Calcium ion channels open **AND** calcium ions move/diffuse into the cells (at the base of the hairs); [1 mark]
- A large enough receptor potential is generated / a threshold is reached; [1 mark]
- An action potential travels / is passed across the leaf (causing it to close); [1 mark]

**[Total: 4 marks]**

Note that you need to explain the events that lead to the closing of the trap, so while stimulation of a single hair does cause the release of calcium ions, it is the stimulation of two hairs that causes enough calcium ions to move into the cells to trigger an action potential. This can be seen in Fig. 2.

1c

c) i) The genes expressed at threshold B could be…

- (Genes that code for) digestive enzymes / production of vesicles that contain enzymes **OR** molecules that cause the trap to close more tightly / seal the trap; [1 mark]

c) ii) The benefit to the plant of not changing gene expression until a second threshold is reached is that…

- The plant does not waste energy expressing new genes / changing its gene expression; [1 mark]
- If the insect/prey has escaped / not been trapped; [1 mark]

***Accept*** *reverse answer for part c) ii).*

**[Total: 3 marks]**

This is a suggested question, but you should be aware that further stimulation seals the trap and leads to the release of digestive enzymes, so the change in gene expression must be

connected to one of these events.

Multiple hair stimulations are required for the second threshold to be reached, meaning that this threshold is only reached if the prey has been caught in a trap and continues moving. If the prey manages to escape then it will be a waste of the plant's energy resources to start secreting digestive enzymes.

2a

a) An action potential is stimulated in an animal neurone as follows...

Any **two** of the following:

- A stimulus causes sodium ion channels to open; [1 mark]
- Sodium ions diffuse into the neurone/cell/axon / there is an influx of sodium ions down a concentration gradient; [1 mark]
- The inside of the cell becomes more positive in comparison to the outside / the charge across the membrane is reversed; [1 mark]

**[Total: 2 marks]**

This is an 'outline' question, so details about receptor potentials, voltage-gated channels and thresholds are not required for the marks. Note that the focus is on depolarisation rather than on reaching action potential; this is the reversal of charge across the membrane.

2b

a) i) The cells of *M. pudica* become depolarised in the next stage of the process shown in Fig. 1 by...

- Chloride ions diffuse out of the cell / move out of the cell down a concentration gradient; [1 mark]
- The loss of negatively charged ions causes the inside of the cell to become more positive; [1 mark]

a) ii) Repolarisation could occur by...

Any **two** of the following:

- The opening of potassium ion channels (in response to depolarisation); [1 mark]
- Potassium ions diffusing out of the cell; [1 mark]
- The loss of positively charged ions causes the inside of the cell to become more negative / restores the resting state; [1 mark]

**[Total: 4 marks]**

This is quite a tricky question, but you have been given quite a lot of information in Fig. 1 and you should be able to apply what you know about depolarisation in animal cells and in venus fly traps.

Depolarisation involves the inside of the cell becoming more positive; this can be achieved either by a gain of positively charged ions or a loss of negatively charged ions. In this case, you have been told that a stimulus leads to the opening of chloride ions and Fig. 1 shows chloride ions inside the cell; it is, therefore, logical to think that an outward movement of negatively charged chloride ions causes depolarisation.

You already know that an outward movement of potassium ions leads to repolarisation in animal neurones. Fig. 1 shows potassium ions and a corresponding potassium ion channel. Logic says that the opening of the channel would lead to the outward movement of positive potassium ions, restoring resting potential.

2c

c) The process described in part b) could lead to a reduction in leaf volume because…

Any **two** of the following:

- Ions leave the cell (both chloride and potassium ions); [1 mark]
- This lowers the water potential of the surrounding tissues/cells; [1 mark]
- Water leaves the cell by osmosis / down a water potential gradient; [1 mark]

**[Total: 2 marks]**

This is another tricky question, but you should have a good idea that osmosis is the cause of water movement in living organisms, so you just need to work backward from here. If osmosis is going to take place then it must be due to the generation of a water potential gradient. This could have been achieved in the process from part b) when ions left the cell by diffusion.

2d

d) The advantage to *M. pudica* of the response shown in Fig. 2. is…

- It reduces leaf surface area / prevents organisms from sitting on its leaves/stems/branches; [1 mark]
- This reduces the risk of being eaten / predation; [1 mark]

**[Total: 2 marks]**

You are not expected to know about adaptations against predation but Fig. 2 should provide you with the information you need to reason your way to the answer. Fig. 2 shows that when touched the leaf folds up and drops downwards; this should suggest a defense mechanism, allowing the mimosa to defend against predators by reducing the available leaf area to eat and by causing small animals to fall to the ground.

3a

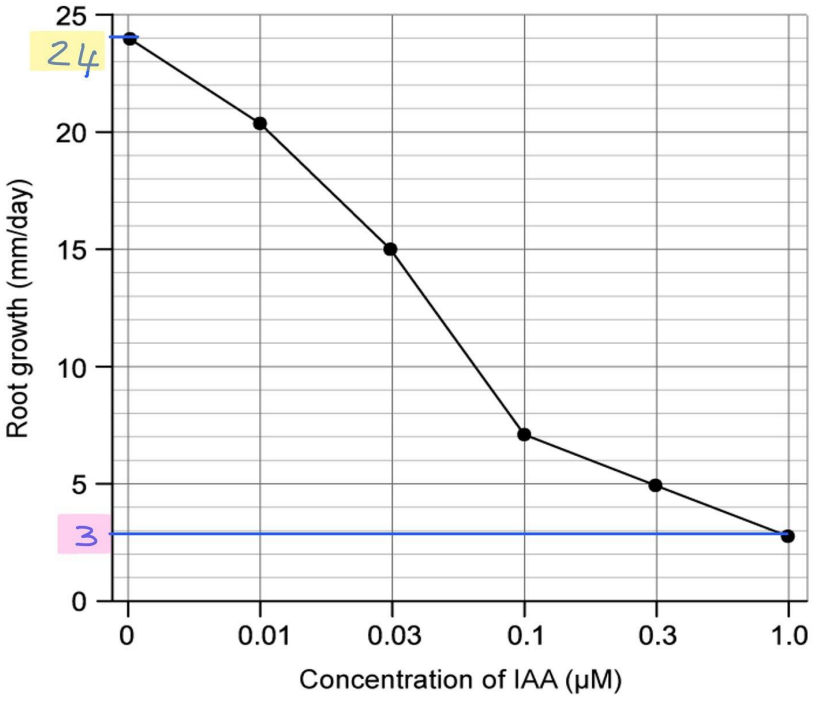
(a) The difference in the root growth per hour can be calculated as follows…

- Conversion: 1 mm/hour **AND** 0.125 mm/hour; [1 mark]
- (1 - 0.125) = 0.875 mm/hour; [1 mark]

*Full marks awarded for the correct answer in the absence of other calculations*

**[Total: 2 marks]**

Remember that it good practice to always show your working to ensure that you get at least [1 mark], even if your answer is incorrect.




Step 1: Convert to mm/hour

= 24 ÷ 24 (→ 24 hours per day) = 1 mm/hour

= 3 ÷ 24 = 0,125 mm/hour

[1 mark]

Step 2: Subtract

1 − 0,125 = 0,875 mm/hour [1 mark]

3b

(b) The growth of the root could have been affected in the following way...

- Auxins/IAA would accumulate on the lower side of the root (due to gravity) **OR** the lower side of the root would have a high(er) auxin/IAA concentration than the upper side of the root; [1 mark]
- This would inhibit/decrease cell growth/elongation on the lower side of the root; [1 mark]
- Causing the tip of the root to grow downwards / towards gravity; [1 mark]

*Ignore reference to the root "bending" downwards for marking point 3*

**[Total: 3 marks]**

Even though you are not expected to be familiar with the effects of auxin on the growth of roots, you are expected to apply the information given in Fig. 1 to this unfamiliar scenario to come up with an answer. Fig. 1 shows that an increase in auxin concentration will decrease or inhibit root growth, which would cause the upper part of the pot plant root to elongate more than the lower part, causing the tip of the root to grow downward.

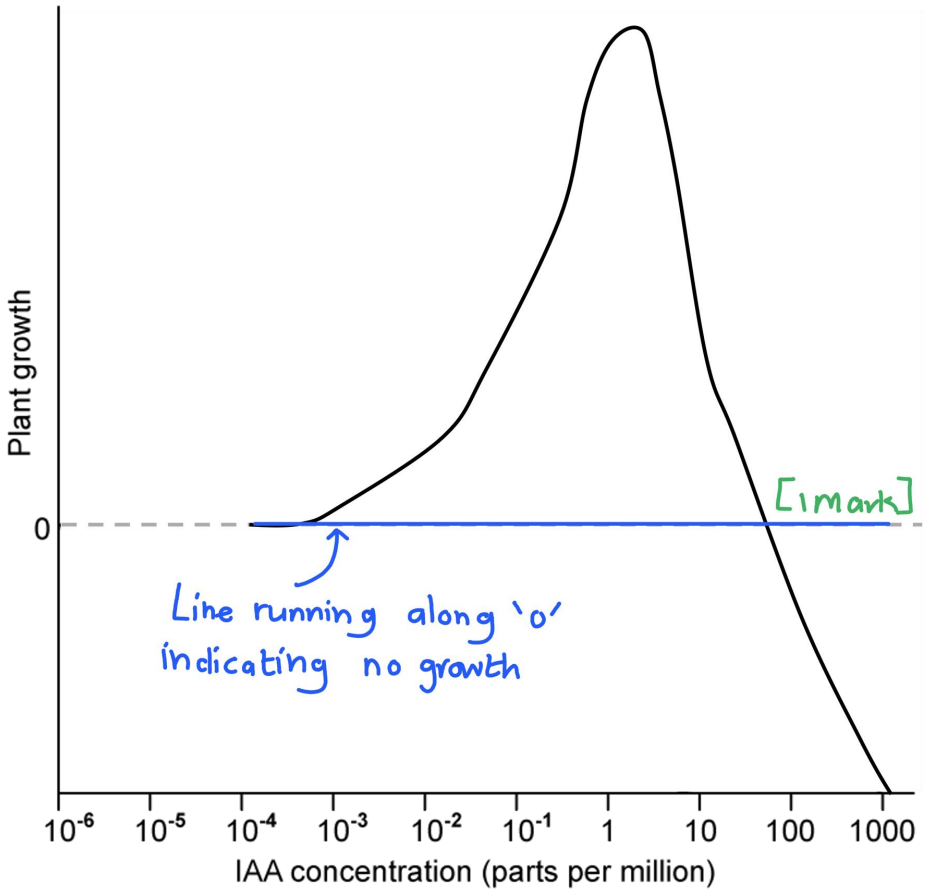
3c

(c) The mark allocation for the sketch of the graph would be as follows...

- A straight line that runs along the '0' dotted line; [1 mark]

**[Total: 1 mark]**

Your graph would look like this...




3d

(d) A possible reason for the line indicating no growth would be...

- No / very little ATP/energy would be released (in the absence of respiration); [1 mark]
- Therefore the proton pumps cannot pump hydrogen ions / $H^+$ into the cell wall; [1 mark]
- This results in the cell wall remaining rigid / unable to stretch and cell growth through elongation would not occur; [1 mark]

**[Total: 3 marks]**

Remember that proton pumps require energy to function as they are moving ions against their concentration gradient. Cellular respiration is the main source of energy in the cell, so if this process is inhibited, then these proton pumps cannot function anymore. Without cell walls that are able to stretch, the cell cannot increase in size and no growth would be observed in the shoots.