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ANSWER BOOK

Plant disease and plant defences

Pathogens, disease and immunity · Unit B11

AQA not examined as a topic · OCR A 4.1.1, 5.1.5 · Edexcel A not examined as a topic
CAIE 15.2

15 questions · 49 marks

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SECTION A · Short, 1 to 2 marks

A1 PDP-Q7

B1 ring rot is caused by a bacterium, **Clavibacter** sepedonicus, which infects the vascular tissue. **B1** tobacco mosaic virus needs no vector and spreads by contact, from leaf to broken leaf and on tools and hands. [2]

A2 PDP-Q15

B1 an outbreak leads to statutory action: the infected stock is destroyed, equipment is disinfected, and restrictions are placed on growing potatoes on the affected land. **B1** symptomless tubers can still carry the bacterium, so infected seed tubers, and the machinery or washing water that touched them, can be moved to a new field before anyone knows the crop is infected. [2]

SECTION B · Standard, 3 to 5 marks

B1 PDP-Q1

B1 ring rot is a notifiable disease, so the infected stock is destroyed, the machinery and washing water that touched it are disinfected, and the land grows something other than potatoes for several years. **B1** the tubers are the route, and infected ones can look healthy, so future crops must be grown from certified disease-free seed potatoes. **B1** the tomatoes have tobacco mosaic virus, so infected plants are removed and destroyed rather than composted, since the virus survives for years in dried plant material. **B1** spread is by contact through wounds, so hands and tools are washed and disinfected between plants, tobacco is kept away from the glasshouse, and resistant varieties are grown in future seasons. **B1** neither disease can be cured: there is no chemical that clears a bacterium from the vascular tissue of every plant in a field, and no antibiotic acts on a virus, so all the useful action is containment before and around infection rather than treatment of it. [5]

B2 PDP-Q2

B1 callose, a polysaccharide of beta-1,3 linked glucose, is laid down between the cell membrane and the wall within minutes of the infection being detected. **B1** it plugs the plasmodesmata, the channels connecting cell to cell, so the pathogen cannot spread from the infected cells to their neighbours. **B1** it also seals the sieve plates of the phloem, which would otherwise carry a virus the length of the plant in hours in the flowing sap. **B1** over the following days lignin, the tough waterproof polymer of woody tissue, is deposited in and around the walls of the infected region, making the barricade permanent with the pathogen walled in. [4]

B3 PDP-Q3 [4]

B1 alkaloids are bitter, nitrogen-containing compounds, caffeine, nicotine, morphine and quinine among them, which are toxic to herbivores or deter them from feeding. **B1** tannins are phenolic compounds that bind proteins, inactivating the digestive enzymes of whatever is chewing and making the tissue bitter, so an insect eating tannin-rich leaf grows slowly or gives up. **B1** a plant being chewed releases volatile signals that drift downwind, and parasitic wasps follow the plume to lay their eggs in exactly those caterpillars, so the plant summons its herbivore's own enemy. **B1** neighbouring plants detect the same volatiles and raise their tannin and toxin levels before they are bitten; some plants add movement, as **Mimosa** pudica does when a touched leaf folds and dislodges insects.

B4 PDP-Q4 [4]

B1 bending a trigger hair opens stretch-sensitive ion channels at its base, and the depolarisation fires an action potential across the trap. **B1** one action potential is held as a raised calcium ion concentration that decays over tens of seconds, so only a second touch within that window takes the calcium concentration past threshold and commits the trap. **B1** a raindrop or a blown seed touches once whereas prey walks, and walking touches twice, so the count is a filter against false alarms, which would cost the plant energy and hold its photosynthetic surface folded shut for a day. **B1** a caged insect struggles and bends the hairs again, so about five action potentials in total confirm live prey before the glands are switched on and the enzymes are spent; a trap closed on debris receives no further touches and simply reopens.

B5 PDP-Q8 [4]

B1 touching the leaf generates an electrical signal, an action potential, that travels away from the point touched. **B1** at each leaflet's hinge, a pad of cells called the pulvinus, potassium ions leave the cells on one side. **B1** water follows the potassium ions out of those cells by osmosis, so turgor in them falls. **A1** the loss of turgor on one side of the hinge makes it fold, closing the leaflets together.

B6 PDP-Q5 [3]

B1 both detect the invader chemically as something that should not be there: a plant recognises molecules characteristic of pathogens and fragments of its own damaged walls, whereas a mammal recognises non-self antigens. **B1** a mammal brings phagocytes and lymphocytes to the site in the blood, whereas a plant has no circulating cells at all and each cell defends where it stands, sealing with callose and lignin and poisoning with its own chemistry. **B1** a mammal makes antibodies and keeps memory cells, so it acquires immunity, whereas a plant makes neither, so it learns nothing from an infection and has no immunity to the same pathogen next season.

B7 PDP-Q6 [3]

B1 a chitinase hydrolyses chitin, which is the polymer of fungal cell walls and of insect exoskeletons. **B1** no plant cell contains chitin, since a plant cell wall is made of cellulose, so the enzyme has no substrate in the plant and the weapon can be deployed freely. **B1** defensins, small proteins that damage bacterial membranes, or phenols, act against bacteria.

B8 PDP-Q9

B1 the virus damages chloroplasts in the infected patches of leaf, so those patches lose their chlorophyll, which produces the mottled (mosaic) pattern. **B1** chlorophyll is needed to absorb light for photosynthesis, so the rate of photosynthesis in the affected leaf tissue falls. **A1** with less photosynthesis taking place, less sugar is available for growth, so the plant's growth is stunted. [3]

B9 PDP-Q10

B1 callose deposited at the sieve plates blocks the flow of sap through the phloem in that region, which is what stops the virus travelling with it. **B1** the phloem, however, is also how the plant normally transports sugars from where they are made to where they are needed. **A1** sealing the sieve plates therefore also blocks translocation of sugars through that same region, so containment comes at a cost to the plant's own transport. [3]

B10 PDP-Q11

B1 a plant's structure is modular, built of many repeated parts such as leaves and branches, so one part can be lost without the whole organism failing. **B1** most plant organs are not unique, so growth continues from meristems elsewhere on the plant even after a branch is walled off and sacrificed. **A1** an animal's organs, such as the heart, are not modular in this way; each animal usually has only one, so damage to it cannot simply be sacrificed and grown around. [3]

B11 PDP-Q12

B1 a repellent, such as citronella from lemon grass, acts before an insect bites, deterring it from feeding on or landing on the plant at all. **B1** an insecticide, such as the pyrethrins made by chrysanthemums, acts on an insect that has already begun to feed, poisoning or killing it. **A1** so a repellent reduces the number of insects that attack the plant in the first place, whereas an insecticide reduces the damage done by insects that attack anyway. [3]

B12 PDP-Q13

B1 different plant species have evolved different defensive compounds against different herbivores and pathogens, so the range of chemicals available across all plant species is very large. **B1** some of these compounds, such as quinine and morphine, have turned out to be useful as human medicines once isolated and tested. **A1** if a plant species becomes extinct before its defensive compounds have been investigated, any medically useful chemistry it made is lost permanently and cannot be recovered. [3]

B13 PDP-Q14

B1 digesting an insect releases nitrogen-containing compounds, such as amino acids, which the plant absorbs through the trap wall. **B1** this supplements the nitrogen the plant cannot obtain in sufficient quantity from the nitrogen-poor, waterlogged soil it grows in. **A1** it is a nutritional adaptation rather than a defence, because its purpose is to obtain a nutrient the plant needs, not to protect the plant from being eaten or infected. [3]

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