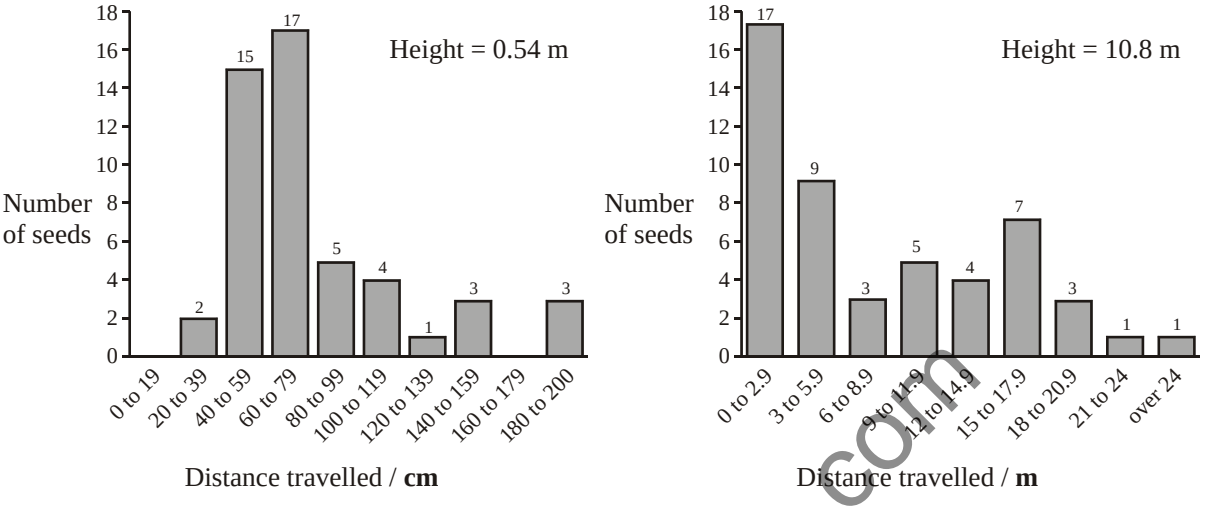
1. Seed dispersal is important in the migration of plants from one area to another area. Plants have evolved many methods, both physical and biological, by which to disperse their seeds.

50 maple seeds, which are wind dispersed, were dropped one at a time from two different heights, 0.54 m and 10.8 m respectively. The histograms below show the distribution of the distance the maple seeds travelled.



[Source: student experiment, Guralnick]

(a) For each height, identify the distance travelled by the greatest number of seeds.

(i) Height = 0.54 m: .....

(ii) Height = 10.8 m: .....

(1)

(b) State the effect of height on seed dispersal.

.....

(1)

(c) Suggest **two** reasons for the effect of the drop height on the distance travelled by the seeds.

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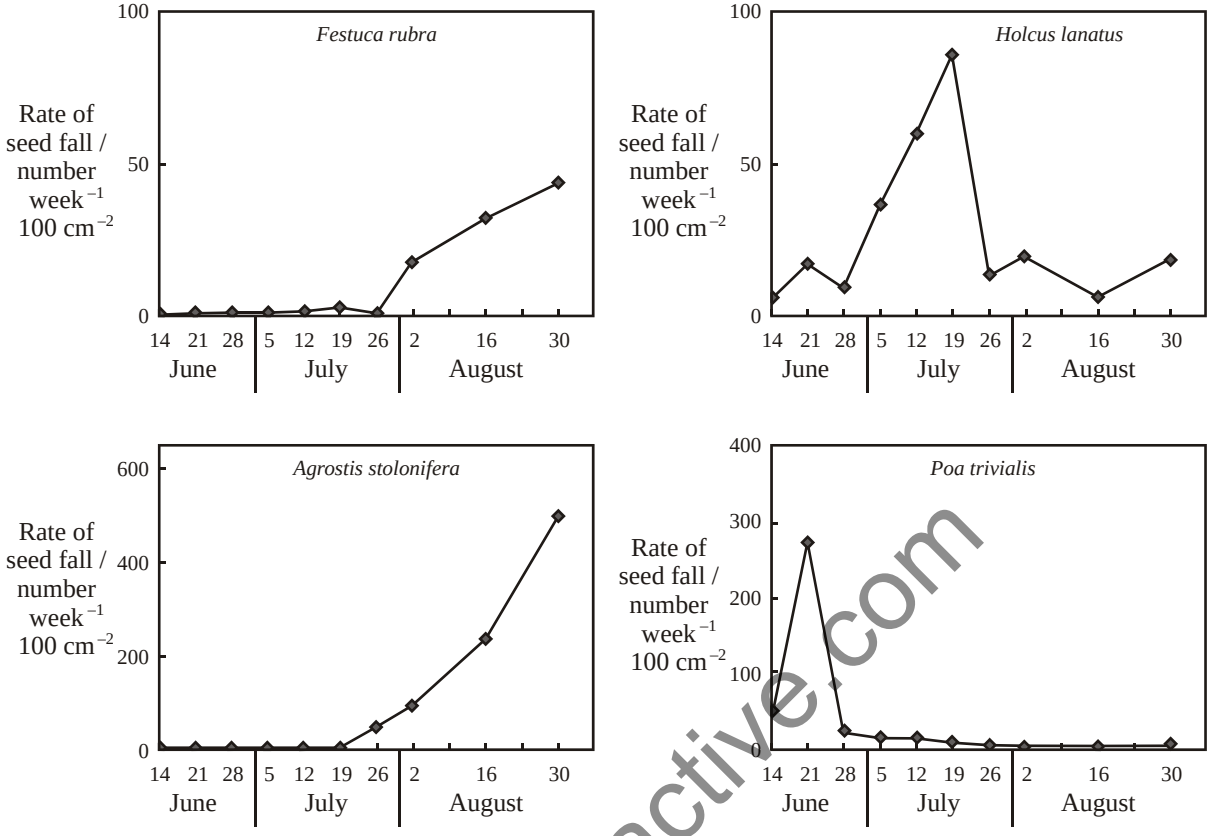
(2)

The following graphs show the rate and timing of seed release from different species of grass in the same area during the summer.



[Source: J L Harper, *Population Biology of Plants,* Academic Press (Harcourt Brace Jovanovich) 1997, page 57]

(d) Identify the grass species which produces the most seeds in this area.

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(1)

(e) Identify the grass species which produces the most seeds in June.

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(1)

(f) Compare seed production for all species relative to the timing of their release.

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(3)

(g) Suggest **two** benefits for these plants in the timing of seed release.

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(2)

Biological seed dispersal is usually dependent on the nutritional content of the seed or fruit. The following table gives the nutritional content for fruits of different species in temperate and tropical climates.

Common Name *(genus)*	Percentage by Dry Weight			Dispersal Agents
	Protein	Lipid	Carbohydrate	
Temperate				
Cranberry *(Vaccinium)*	3	6	89	Birds
Hawthorn *(Crataegus)*	2	2	73	Birds
Pin cherry *(Prunus)*	8	3	84	Birds
Pokeberry *(Phytolacca)*	14	2	68	Birds
Strawberry *(Fragaria)*	6	4	88	Birds
Tropical				
Bird palm *(Chamaedorea)*	14	16	55	Birds
Fig *(Ficus)*	7	4	79	Bats
Mistletoe *(Viscum)*	6	53	38	Birds
Monkey fruit *(Tetragastris)*	1	4	94	Monkeys
Wild nutmeg *(Virola)*	2	63	9	Birds

[Source: H Howe and L Westley, *Ecological Relationship of Plants and Animals*, Oxford University Press 1988, page 121]

(h) Compare tropical fruits to temperate fruits in relation to the mean values for lipid, carbohydrate and protein content.

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(2)

(i) Explain which fruit would have the highest energy content.

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(2)

(j) Suggest **one** advantage and **one** disadvantage of dispersal of seeds by animals.

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(2)

(Total 17 marks)

2. Outline the role of the phloem in the active translocation of biochemicals.

(Total 5 marks)

3. Describe the metabolic events of germination in a starchy seed.

(Total 5 marks)

4. Explain how abiotic factors affect the rate of transpiration in a terrestrial plant.

(Total 8 marks)

5. Organic farmers sometimes claim that fruit and vegetables grown organically taste better than the same varieties grown using non-organic methods. To test this theory and other claimed advantages of organic farming, crop scientists set up trial plots on which apples were grown using three different production systems:

- organic (no artificial fertilizer or spray chemicals used)
- conventional non-organic (artificial chemical fertilizers and spray chemicals used)
- integrated (organic and non-organic methods combined, to reduce artificial chemical use).

A group of consumers tested the apples for flavour, firmness, sweetness and sourness (acid taste). The acidity of the fruit was also measured by chemical analysis. The table below shows the mean results.

Test	Organic	Conventional non-organic	Integrated
Flavour 1 = dislike extremely 9 = like extremely	6.0 *a*	5.9 *a*	6.7 *b*
Firmness 1 = very soft 9 = very hard	5.5 *a*	5.3 *a*	5.1 *a*
Sweetness 1 = not at all sweet 9 = extremely sweet	5.6 *a*	5.0 *b*	5.6 *a*
Sourness 1 = not at all sour 9 = extremely sour	3.6 *a*	4.7 *b*	4.8 *b*
Measurable acidity / %	0.49 *a*	0.52 *ab*	0.54 *b*

[Source: Reganold, *et al*., *Nature*, 2001, **410**, pages 926–929]

The letters *a* and *b* after the values in each test indicate whether the differences between the means are significant or not. If the letters in a test are the same, the difference is too small for any conclusions to be drawn. If the letters are different, there is a significant difference.

(a) (i) Identify **one** test in which there were no significant differences between the mean results for the three systems.

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(1)

(ii) Identify **one** test in which the mean result for the conventional system was significantly different from those for the other two systems.

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(1)

(b) The acidity of the apples was tested both by chemical analysis and by the group of consumers. Compare the results obtained by these two methods.

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(2)

(c) Evaluate the hypothesis that the taste of apples is better if organic rather than conventional methods are used to grow them.

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(2)
(Total 6 marks)

6. Light, water and carbon dioxide concentration all affect the productivity of crop plants.

(a) State **two** other factors that affect plant productivity.

1. .....

2. .....

(2)

(b) Explain how plant productivity can be increased by growing crops in greenhouses.

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(3)
(Total 5 marks)

7. Draw the structure of a dicotyledenous animal-pollinated flower.

(Total 6 marks)

8. Compare the adaptations of xerophytes and hydrophytes.

(Total 8 marks)

9. Describe how water is transported in a plant.

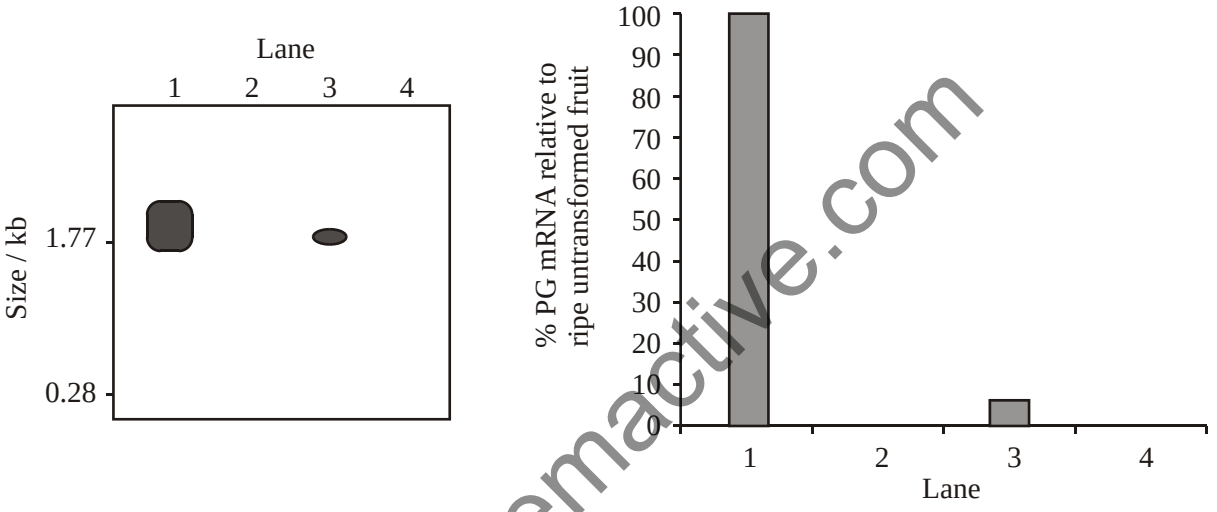
(Total 4 marks)

10. Polygalacturonase (PG) plays an important role in fruit softening by making the pectin of the cell wall more soluble. It is synthesized only when the fruit is ripe.

In order to slow down the ripening of tomatos (*Lycopersicon esculentum*), antisense RNA technology was used. Messenger RNA from untransformed and transformed fruit was hybridized to a radioactively labelled probe specific to the PG sense strand.

The results of a gel electrophoresis of mRNA are given below. (The size of the mRNA strands is expressed in kilobases, kb.) The histogram shows these results expressed as the percentage of PG mRNA in ripe untransformed fruit.

Lane 1: Ripe untransformed fruit
Lane 2: Unripe untransformed fruit
Lane 3: Ripe transformed fruit
Lane 4: Unripe transformed fruit



[Source: Smith *et al.*, *Nature*, (1988), **334**, pages 724–726]

(a) State the percentage of PG mRNA in ripe transformed fruit.

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(1)

(b) Compare the results obtained for ripe and unripe fruit.

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(2)

(c) Using the information provided, explain how the antisense technology affects transformed fruit.

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(3)
(Total 6 marks)

11. (a) State **one** way in which we make use of domesticated animals.

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(1)

(b) (i) Define the term *interspecific hybridization* in plant breeding.

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(1)

(ii) Outline **one** example of polyploidy.

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(2)
(Total 4 marks)

12. Outline crop production by hydroponics.

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(Total 3 marks)

13. Explain the technique used in cloning by micropropagation.

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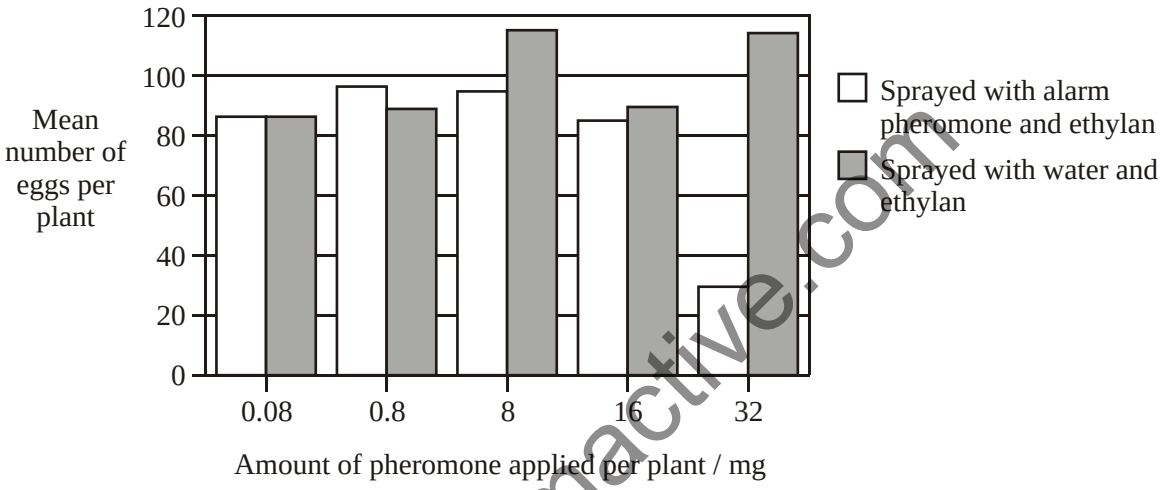
(Total 7 marks)

14. Entomologists studied two species of insect pest, the cabbage root fly (*Delia radicum*) and the peach-potato aphid (*Myzus persicae*). Both of these insects are pests on the cauliflower plant (*Brassica oleracea*). They wanted to see if the presence of one pest on a plant would repel another pest species.

When it is disturbed, the peach-potato aphid produces an alarm pheromone, a chemical signal that disperses in the air. Five sets of 15 cauliflower plants were each sprayed with different levels of the aphid's pheromone dissolved in ethylan. Another five sets of cauliflowers were treated with distilled water and ethylan. (Ethylan helps to spread the pheromone over the surface of the plants.)

Mature cabbage root fly females were released into the cages where the treated cauliflower plants were growing. They were left for one day and the number of eggs laid by the female root flies were counted. The data is shown in the bar chart below.



[Source: S Finch and T S Jones (1989), *Ecological Entomology*, **14**, pages 387–391]

(a) Compare the results of treatments with and without the pheromone.

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(2)

(b) Suggest a reason why aphids produce an alarm pheromone.

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(1)

Each aphid can release about 1 ng of pheromone (1 ng = 10^{-9} g).

(c) Calculate how many aphids must simultaneously release pheromone to produce 32 mg.

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(1)

(d) Discuss the possible use of peach-potato aphids to control the cabbage root fly pest.

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(3)

(Total 7 marks)

15. (a) Distinguish between plant growth regulators and fertilizers.

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(2)

(b) Explain the techniques used in cloning by micropropagation of plants.

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(3)

(c) Outline the effects of pruning on plants

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(2)
(Total 7 marks)

16. (a) Define *outbreeding*.

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(1)

(b) Discuss the importance to farmers of maintaining biodiversity of **either** wild plants **or** ancient farm breeds.

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(3)
(Total 4 marks)

17. Which would be an adaptation of xerophytes?

A. Large air spaces

B. Large numbers of stomata

C. Hairs on the leaves

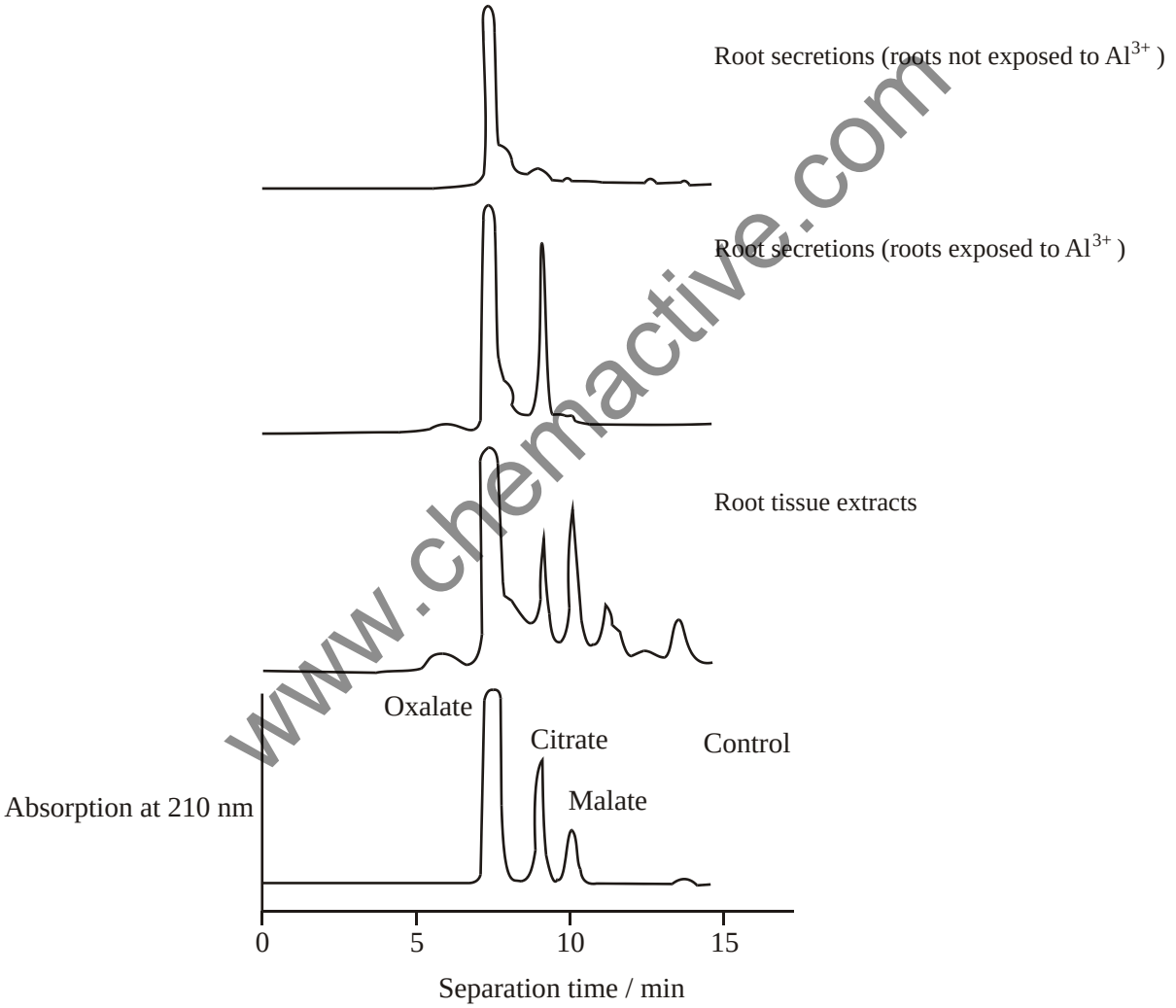
D. Reduced roots

(1)

18. The element aluminium (Al) makes up 7 % of the Earth's crust, usually combined as harmless oxides and silicates. However, when the soil becomes acidic, aluminium becomes soluble as Al^{3+}, a toxic ion. The presence of Al^{3+} inhibits root growth which then affects nutrient and water uptake by the roots.

Some plants, such as maize and wheat, have evolved mechanisms to tolerate aluminium stress. Evidence indicates that the roots of such plants secrete organic acids, including oxalate, citrate and malate, all of which are involved in the Krebs cycle. These organic acids form stable, non-toxic complexes with Al^{3+} ions.

In an experiment, *Cassia tora* roots were exposed for 9 hours to solutions with or without Al^{3+} ions. The organic acids in the extracts of root tissue were compared with those secreted into the solution by means of HPLC (high pressure liquid chromatography). The acids were separated by this technique and their presence detected by their absorption of light at 210 nm. Each acid was identified by the time taken for separation to occur.



[Source: J Feng Ma, P R Ryan and E Elhaize, (2001), *Trends in Planet Science*, **6**, pages 271–278]

(a) Identify which acid is secreted from the root in response to the presence of Al^{3+} ions.

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(1)

(b) Identify the organelle of the root cells where all these organic acids would be found.

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(1)

(c) Explain why more acids are found in the root tissue extracts than in the root secretions.

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(1)

Hydrangeas are plants that are grown in gardens in many parts of the world because of their large, colourful flowers. It has been shown that the different colours are due to the ability of the plant to accumulate high concentrations of Al^{3+} in the flowers, changing their colour from pink to blue.

(d) Discuss different methods that a flower grower might use, based on the information from the aluminium research, to produce different colours of *Hydrangea* flowers.

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(3)
(Total 6 marks)

19. (a) Compare biological issues surrounding organic and non-organic farming methods.

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(2)

(b) Distinguish between growth regulators and fertilizers.

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(2)
(Total 4 marks)

20. Discuss the use of asexual reproduction in the artificial propagation of plants.

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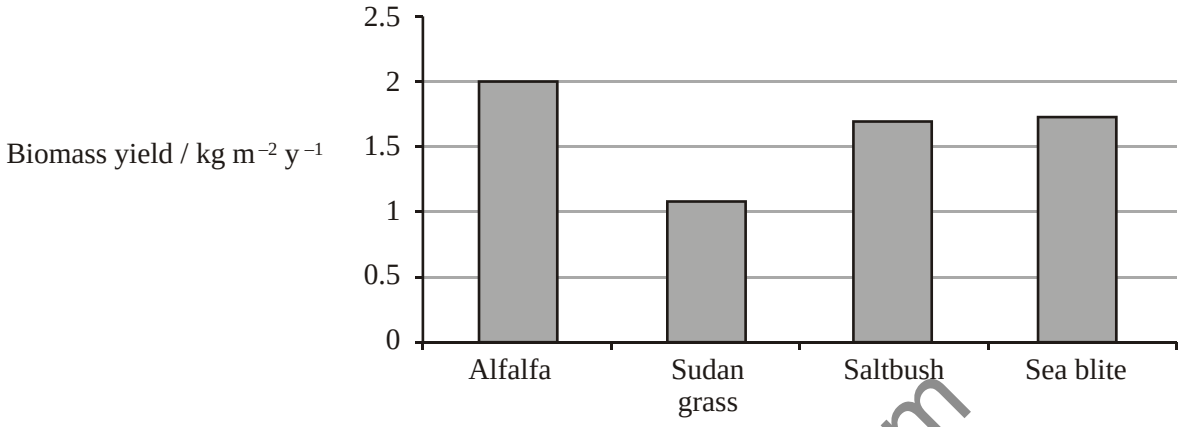
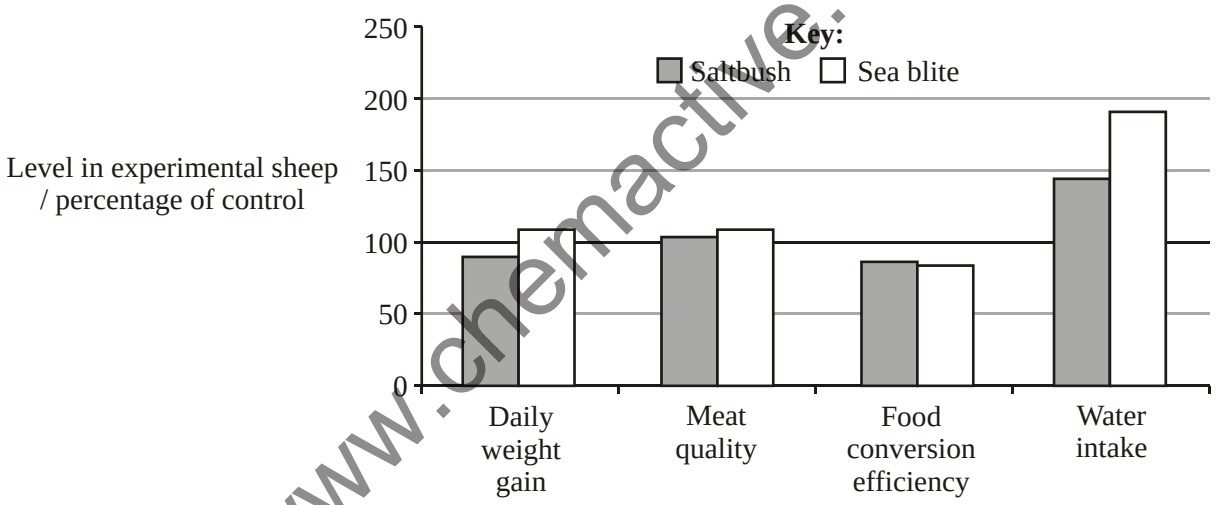
(Total 6 marks)

21. As the world's population grows, supplies of freshwater are becoming scarcer. Researchers are investigating the use of sea water to irrigate selected crops which can be fed to livestock. The biomass yield of two freshwater-irrigated plants often used for livestock forage, alfalfa (*Medicago sativa*) and Sudan grass (*Sorghum sudanense*), were compared with those of salt-tolerant crops irrigated by seawater, saltbush (*Atriplex spp*.) and sea blite (*Sueda maritima*). The results are shown in the bar chart below.



Sheep were raised on a normal diet (control sheep) and compared with sheep fed on a normal diet supplemented with salt-tolerant plants. The results are shown in the bar chart below.



[Source: E Glenn *et al*., *Scientific American*, (August 1998) pages 56–61]

(a) Compare the biomass yield of crops irrigated with seawater and freshwater.

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(2)

(b) Compare the daily weight gain and water intake in sheep fed on saltbush with sheep fed on sea blite.

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(2)

(c) Discuss, using only the data provided, the advantages and disadvantages of using crops irrigated by seawater to feed sheep.

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(3)
(Total 7 marks)

22. (a) State **two** ways in which animals are useful to humans.

1. .....

2. .....

(2)

(b) (i) Define the term *F1 hybrid vigor*.

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(1)

(ii) Explain how plant-breeding programmes have led to improvement in the yield of rice crops.

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(3)
(Total 6 marks)

23. (a) List **two** roles of auxins in plants.

1. .....

2. .....

(2)

(b) Explain **three** ways in which a greenhouse can improve the productivity of plants.

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(3)
(Total 5 marks)

24. (a) State **one** example of a plant grown to provide clothing.

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(1)

(b) Discuss the practice of organic farming.

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(3)

(c) Outline plant production by hydroponics.

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(3)
(Total 7 marks)

25. (a) State **one** advantage and **one** disadvantage of using antibiotics in livestock production.

Advantage: .....

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Disadvantage: .....

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(2)

(b) Describe how pruning can affect a decorative plant.

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(3)

(Total 5 marks)

26. What is a characteristic of xerophytes?

A. Absence of roots

B. Absence of vascular tissue

C. Leaves with very small surface area

D. Large number of stomata

(1)

27. What causes movement of water through the xylem?

A. Active transport in the root tissue

B. Evaporation of water from leaves

C. Active translocation

D. Gravity

(1)

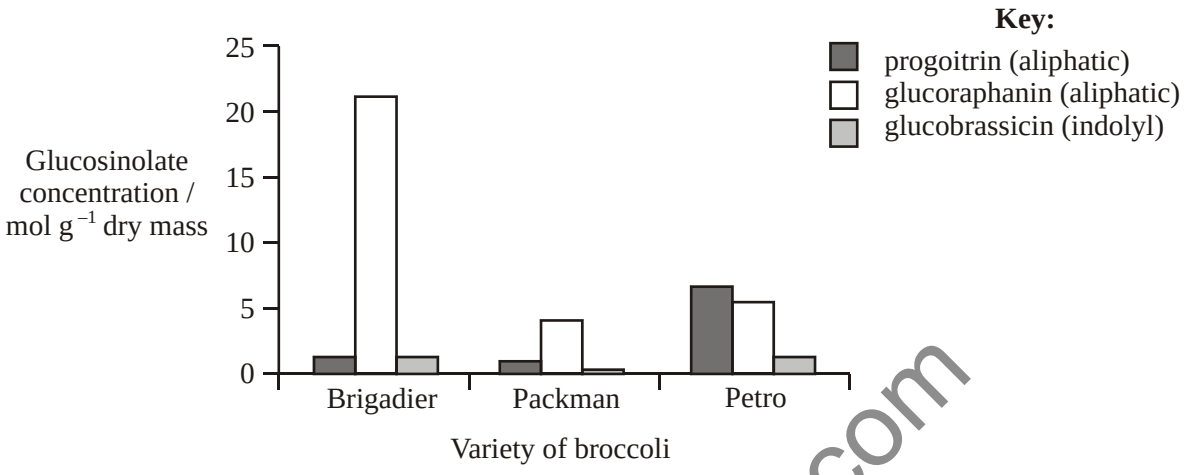
28. The leaves of plants are adapted to absorb light and use it in photosynthesis. Draw a labelled diagram to show the arrangement of tissues in a leaf.

(Total 6 marks)

29. Distinguish between xerophytes and hydrophytes, giving **one** structural adaptation for each type of plant.

(Total 4 marks)

30. Glucosinolates are chemicals found in some vegetables, which are responsible for the taste of horseradish, wasabi and broccoli. There are two types of glucosinolate, aliphatic and indolyl. They have been found to have many positive health effects, including carcinogen detoxification and antioxidant properties. Different varieties of broccoli vary in their content of glucosinolates as shown in the graph below. Researchers have found that 61 % of the variation in aliphatic glucosinolate concentration is due to genetic factors compared with 12 % for indolyl glucosinolates.



[Source: E H Jeffery *et al*., *Nutrition Today*, (2002), **37**, page 208)

(a) Using the graph, compare the amount of aliphatic glucosinolates among the different varieties of broccoli.

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(3)

(b) Using the data, explain how outbreeding could be used to develop a new variety of broccoli with increased glucosinolate content.

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(3)
(Total 6 marks)

31. (a) Define the term *F_1 hybrid vigor*.

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(1)

(b) Describe the advantages of using intensive animal rearing techniques.

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(3)
(Total 4 marks)

32. Outline the need to maintain wild plants for use in breeding programmes.

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(Total 4 marks)

33. Discuss the ethical issues for and against the use of transgenic plants.

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(Total 6 marks)

34. (a) Explain the role of auxin in phototropism.

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(3)

(b) Describe how plant growth regulators can be used commercially to produce fruits without seeds.

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(2)

(Total 5 marks)

35. Draw a labelled diagram of a monocotyledonous wind-pollinated flower.

(Total 4 marks)

36. Explain how manipulation of day length is used in the production of flowers.

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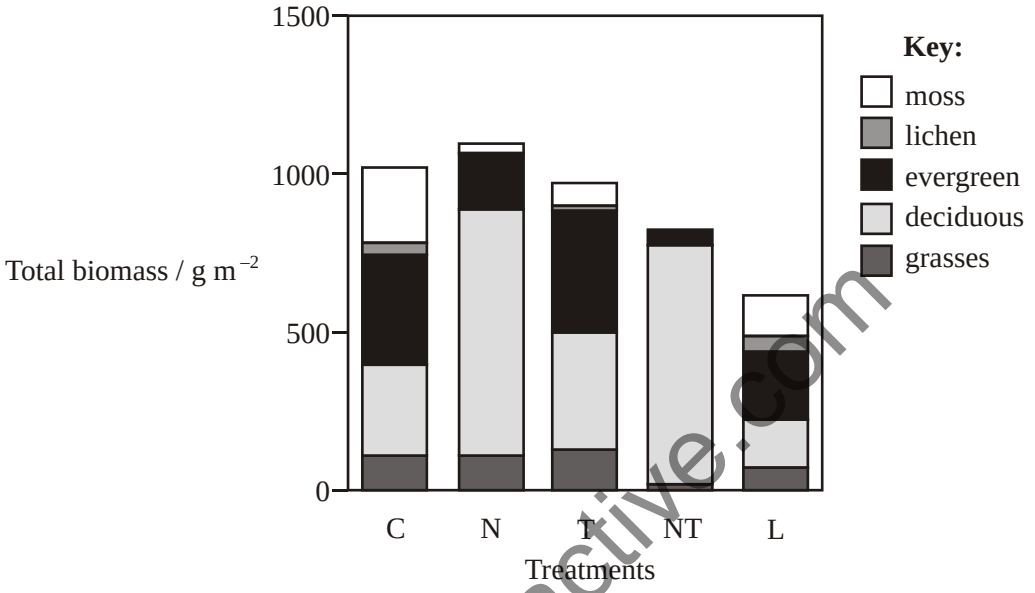
(Total 6 marks)

37. A nine-year study was carried out on plants that grow in the arctic tundra. The effects of different environmental factors were studied:

- nutrient addition
- use of a greenhouse to raise the summer air temperature by 3 °C
- use of a "fertilized greenhouse" (increased temperature plus nutrient addition)
- shade to reduce light by 50 %.

The results are shown in the graph below.



[Source: UNEP, (1995), *Global Biodiversity Assessment*, Press Syndicate of the University of Cambridge, page 295]

(a) Identify the treatment that produced

(i) the greatest evergreen biomass.

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(1)

(ii) the greatest lichen biomass.

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(1)

(b) Compare the effects of nutrient addition, raising the temperature and shading on the biomass of deciduous plants.

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(2)

(c) Suggest reasons for the differences in total biomass of plants in response to the different treatments.

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(2)
(Total 6 marks)

38. (a) Outline the need to maintain biodiversity of **wild** plants.

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(2)

(b) Explain how **one** veterinary technique improves the health of animals.

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(2)
(Total 4 marks)

39. (a) Outline the roles of auxin in plants.

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(3)

(b) (i) State **one** problem that may be caused by intensive monoculture.

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(1)

(ii) Discuss the biological issues of organic versus non-organic farming methods.

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(4)
(Total 8 marks)

40. When a farmer sprays a chemical on to crop plants, how does the chemical travel to the roots of the plants?

A. In the phloem, by active translocation

B. In the phloem, by transpiration pull

C. In the xylem, by transpiration pull

D. In the xylem, by active translocation

(1)

41. Fertilization, pollination and seed dispersal all occur during the reproduction of a flowering plant. In what sequence do these processes occur?

A. seed dispersal ⟶ pollination ⟶ fertilization

B. fertilization ⟶ pollination ⟶ seed dispersal

C. pollination ⟶ fertilization ⟶ seed dispersal

D. seed dispersal ⟶ fertilization ⟶ pollination

(1)

42. Compare the structure of bryophytes and angiospermophytes.

(Total 5 marks)

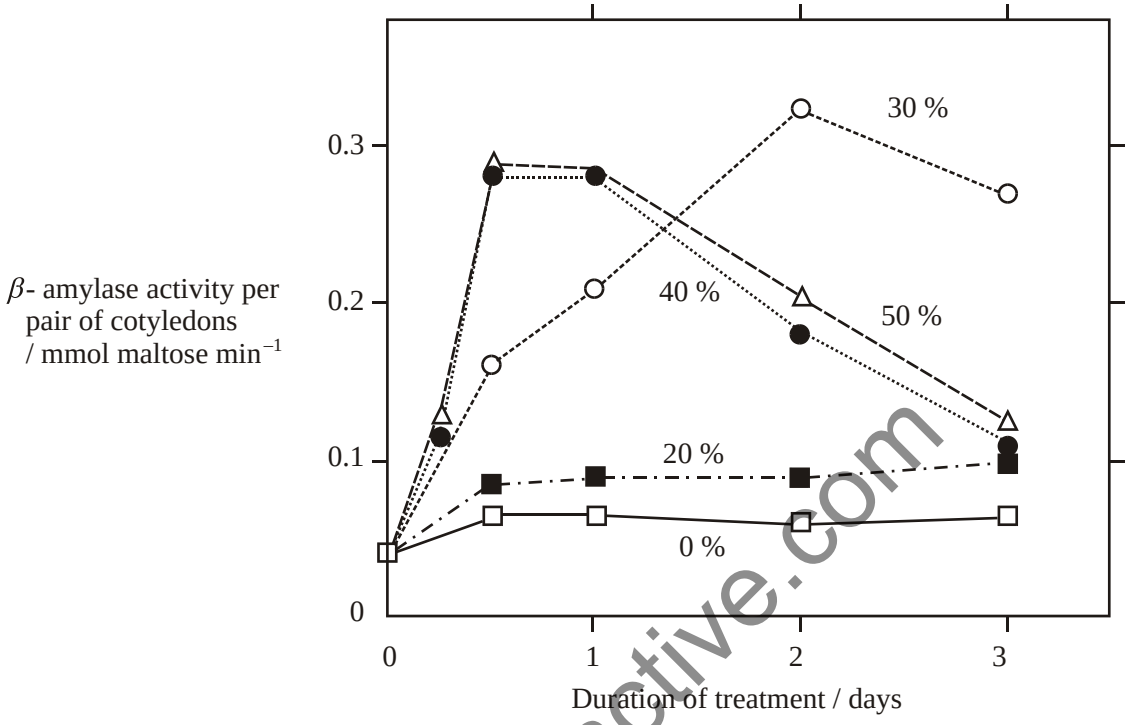
43. Explain how the abiotic factors of light, wind and humidity affect the rate of transpiration.

(Total 8 marks)

44. Describe the metabolic events of germination in a typical starchy seed.

(Total 5 marks)

45. An experiment was carried out to investigate the effect of water stress on cucumber (*Cucumis sativus*) seedlings. Cotyledons were detached from four day old seedlings and treated with polyethylene glycol (PEG), a water absorbing compound. β-amylase activity was measured in cotyledons treated with PEG at concentrations of 0, 20, 30, 40 and 50 %. This enzyme catalyses the conversion of starch into maltose. The mean results are shown in the graph.



[Source: D Todak, *et al.*, (2000), *Journal of Experimental Botany*, 51, pages 739–745]

(a) Identify the maximum activity of β-amylase in the 50 % treatment.

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(1)

(b) Compare the β-amylase activity in the cotyledons treated with 20 % PEG with those treated with 30 % PEG.

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(2)

(c) Deduce the relative free sugar content of the cotyledons treated with 20 % PEG compared to those treated with 3 0 % PEG.

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(1)

(d) Suggest reasons for the change in activity of β-amylase during water stress.

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(2)
(Total 6 marks)

46. (a) State **two** ways in which plant productivity can be measured.

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(2)

(b) Outline the effect of carbon dioxide concentration on plant productivity.

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(2)
(Total 4 marks)

47. Outline the techniques used in cloning plants by micropropagation.

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(Total 4 marks)

48. (a) (i) Define the term *net assimilation rate*.

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(1)

(ii) Outline how net assimilation rate can be used to measure plant productivity.

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(1)

(b) Explain how greenhouses are used to improve plant productivity.

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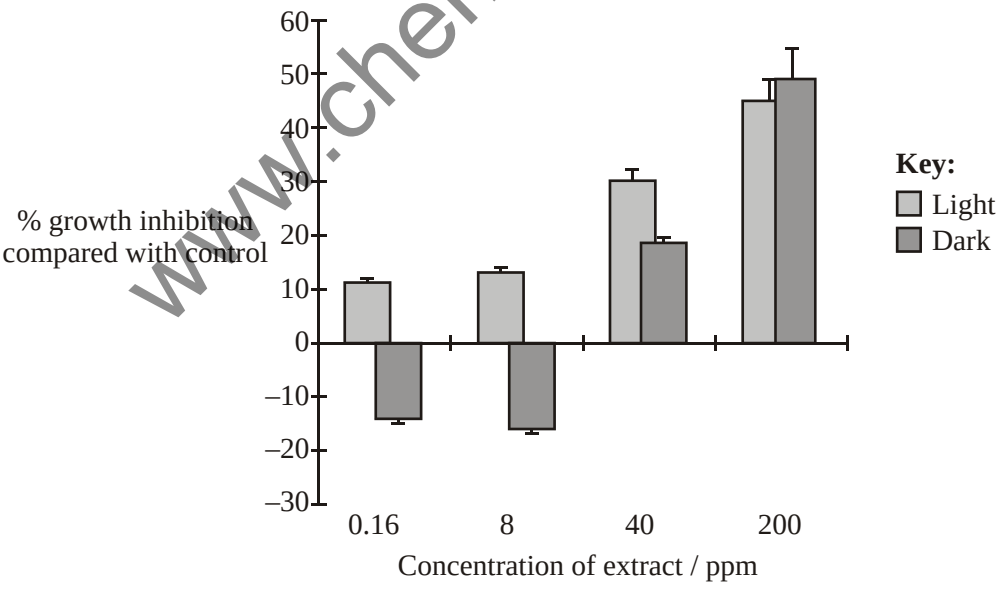
(4)
(Total 6 marks)

49. The leaves of the plant Tree of Heaven (*Ailanthus altissima L.*) have been reported to contain compounds that act as both herbicides and pesticides. Chemicals were extracted from the leaves and the bioactivity of these was tested on the growth of alfalfa seedlings. The results are shown in the bar chart below. Negative values for growth inhibition indicate increased growth.



[Source: adapted from Tsao et al., *BMC Ecology*, (2002), **2**, pages 1–6]

(a) (i) Determine the concentration of the extract that had the greatest difference between dark and light conditions.

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(1)

(ii) State the largest percentage growth inhibition for seedlings grown in the light.

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(1)

(b) Outline the effect of extract concentration on growth in the dark.

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(2)

(c) Suggest reasons for testing the bioactivity of the extract on seedlings in the dark and in the light.

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(2)
(Total 6 marks)

50. (a) Discuss the biological issues surrounding biological and chemical pest control.

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(4)

(b) Discuss the use and misuse of antibiotics in livestock production.

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(3)
(Total 7 marks)

51. (a) Distinguish between plant growth regulators and fertilizers.

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(2)

(b) Explain the role of auxin in phototropism.

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(3)
(Total 5 marks)

52. Which of the following help(s) in supporting a terrestrial woody plant?

I. Xylem tissue

II. Turgor pressure

III. Phloem tissue

A. I only

B. I and II only

C. II and III only

D. I, II and III

(1)

53. Which of the following is a correct comparison of the bryophytes and the filicinophytes?

	Bryophytes	**Filicinophytes**
A.	Has a waxy cuticle	No waxy cuticle
B.	Has true leaves	Has scales
C.	Has rhizoids	Has roots
D.	Has woody tissue	No woody tissue

(1)

54. (a) Describe the role of skin arterioles in the regulation of body temperature.

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(3)

(b) Explain how temperature affects the rate of transpiration from a typical mesophytic plant.

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(3)

(c) Explain the role of temperature on enzyme activity.

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(3)

(Total 9 marks)

55. Explain the process of water uptake and transport by a plant.

(Total 8 marks)

56. State **one** structural feature of each of the following plant groups: bryophytes, angiospermophytes and coniferophytes.

(Total 3 marks)

57. Draw a labelled diagram to show the external parts of a **named** dicotyledonous plant.

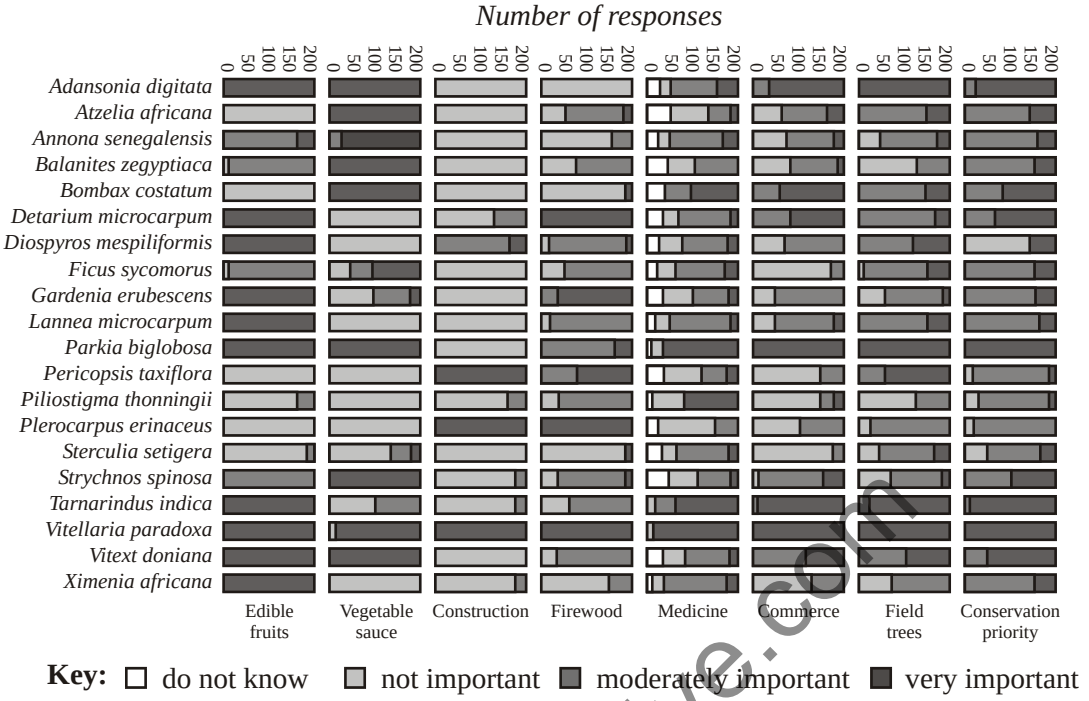
(Total 5 marks)

58. Explain how roots absorb water and then transport it to the xylem, noting any special adaptations that help these processes to occur.

(Total 9 marks)

59. Use and conservation preferences for savanna trees were investigated in a West African country.

Residents from different villages evaluated the importance of 20 woody species for eight different uses: edible fruits, vegetable sauce, construction, firewood, medicine, commerce, field trees and conservation. The following data is based on answers from 200 residents.



[Source: *Economic Botany*; Kristensen and Lykke, reprinted by permission from *Economic Botany*, vol. 57 (**2**), pages 203–217, Kristensen and Lykke. Copyright 2003, The NewYork Botanical Garden, Bronx, New York]

(a) Identify the most important tree species to the villagers.

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(1)

(b) State the category of use for which villagers have most difficulty in finding useful species.

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(1)

(c) Compare the usefulness of species in providing edible fruit with their usefulness for vegetable sauce.

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(2)

(d) Determine the percentage of species that are valued **entirely** as "very important" in at least three categories.

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(1)

(e) Suggest a property of the wood from *P. erinaceus* that makes it one of the preferred species for use in building houses.

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(1)
(Total 6 marks)

60. (a) State **two** adaptations of insect-pollinated flowers.

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(2)

(b) Define the term *net assimilation rate*.

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(1)

(c) Predict what will happen to the flowering process of a short day plant if the minimal dark period is interrupted by brief exposure to light.

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(1)
(Total 4 marks)

61. Discuss the practice of intense monoculture in present-day agriculture.

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(Total 7 marks)

62. Kochia (*Kochia scoparia*) is a common weed in the Great Plains of the United States and Canada. Kochia affects crops by reducing the yield of wheat and corn. Kochia is difficult to control because of its leaf characteristics. The leaves either prevent herbicide contact or the herbicide spray droplets roll off the leaf. Chemicals known as surfactants are detergents which help to aid the retention of herbicides on the leaves of the weeds. Research was undertaken to study the influence of surfactants on the effectiveness of three herbicides in aiding the control of Kochia.

The table below shows the percentage biomass reduction of Kochia using three herbicides with different surfactants.

	Percentage Biomass Reduction		
Surfactant	**Bromoxynil**	**2,4-D-amine**	**Glyphosphate**
No surfactant	95	27	21
Allinol	97	40	9
Mon 0818	95	44	82
Oxysorbic	92	43	71
R-11	94	40	26

[Source: Harbour, *et al*, *Weed Science*, (2003), **51**, page 430]

(a) (i) State which herbicide was most effective in controlling Kochia with no surfactant.

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(1)

(ii) State which surfactant was least effective in controlling Kochia.

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(1)

(iii) Calculate the mean percentage biomass reduction when using surfactants with glyphosphate.

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(1)

(b) Using the data in the table, discuss the advice that should be given to farmers on the use of surfactants.

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(3)
(Total 6 marks)

63. Describe how flowering is controlled in long day plants (LDP)

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(Total 4 marks)

64. Discuss the ethical issues surrounding the use of biological and chemical pest control.

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(Total 6 marks)