

1. (a) height 0.54 m: 60–79 cm / 0.60–0.79 m (from the plant)
and height 10.8 m: 0–2.9 m (from the plant); 1
Units needed for both parts of the answer.
- (b) the greater the height from which the seed fell,
the further it travelled from the parent plant 1
- (c) *at the greater height:*
seed can catch the wind to travel further / updrafts /
more wind at greater height;
farther to the ground and does not travel straight down /
more time to be blown before hitting the ground;

at lower height:
seed can fall straight down;
seed can hit downdraft and fall faster; 2 max
*Any point must explain the difference in distance
travelled from the two heights.*
- (d) *Agrostis stolonifera* 1
- (e) *Poa trivialis* 1
- (f) *Poa* produces seed earliest in the summer / June;
Holcus produces most seed in July;
Agrostis and *Festuca* produce seed in (late July to) August;
Holcus and *Poa* have a peak time of seed fall /
short period of seed fall;
Agrostis and *Festuca* may continue to increase in
seed production to September; 3 max
Accept any of these points made conversely as an alternative.
- (g) *Award [1] each for any two of the following.*
to avoid predation /
disperse at times when other species are dispersing their seeds;
to avoid competition;
late in the year to allow seeds to germinate over winter /
better germination conditions;
better dispersal conditions / more wind / animals for dispersal;
photoperiod – required day length for flowering;
more energy stored at the end of the summer for seed production;
more light / warmth / better conditions for seedling photosynthesis /
growth; 2 max
- (h) *Award [1] each for any two of the following.*
tropical fruits have higher lipid content than temperate fruits;
temperate fruits (80 %) have greater carbohydrate
content than tropical fruits (55 %);
protein levels are similar in both groups of fruits /
slightly higher in temperate fruits
than tropical fruits;
(must make it clear that the difference is slight) 2 max
- (i) mistletoe;
high proportion of lipid and carbohydrate
(lipid has approximately twice the energy content
of protein and carbohydrate); 2

(j) Award [1] for advantage and [1] for disadvantage.

animal dispersal advantage:

travel further / digestion cracks seed coat for better germination /
deposited in feces with organic matter /
better in areas with little wind;

animal dispersal disadvantage:

predation / seeds eaten / deposited in poor environment /
buried too deep / buried too shallow (if deposited with feces) /
animal might become extinct / scarce;

2 max

[17]

2. living tissue;

composed of companion cells / sieve tube members;
companion cells involved in ATP production;
sucrose / amino acids / assimilate /
products of photosynthesis transported;
bi-directional transport;
source / leaves to sink / fruits / roots /
storage organs / named storage organ;
pressure flow hypothesis /
movement of water into phloem causes transport;

[5]

3. absorption of water;

(embryo) increases respiration;
(embryo) secretes GA to (aleurone layer);
(stimulates) production of amylase;
digestion of starch to smaller sugars / maltose;
mobilize to tissues / transport of foods /
nutrients to embryo;

[5]

4. less transpiration as (atmospheric) humidity rises;
smaller concentration gradient (of water vapour);

more transpiration as temperature rises;
faster diffusion / more kinetic energy (of water molecules);
faster evaporation (due to more latent heat available);

more transpiration as wind (speed) increases;
humid air / water vapour blown away from the leaf;
increasing the concentration gradient (of water vapour);

more transpiration in the light;
due to light causing stomata to open;
wider opening with brighter light hence more transpiration;
CAM plants opposite;
narrower stomata with high carbon dioxide
concentration hence less transpiration;

[8]

5. (a) (i) firmness test; 1
(ii) sweetness test; 1
- (b) organic apples were least acid and integrated apples most acid (in both tests);
greater difference between the sourness results than the chemical analysis results;
organic significantly different in sourness from both others but only from
integrated in chemical analysis; 2 max
- (c) flavour of organic not (significantly) different from conventional;
organic apples are (significantly) sweeter than conventional;
organic apples are (significantly) less sour;
personal taste preferences vary / some people prefer less sweet / sour apples;
taste may vary from year to year; 2 max
- [6]
6. (a) temperature;
availability of nutrients;
diseases of the plants;
predators / pests eating the plants;
genotype of the plants;
soil composition / acidity / drainage;
competition / space from other plants; 2 max
- (b) temperature higher inside the greenhouse than outside;
as short wave radiation can pass through the glass and re-emitted long wave cannot;
carbon dioxide levels can be enriched;
humidity levels can be kept higher so there is less transpiration;
biological control of pests works more effectively;
less wind so less transpiration / mechanical damage to crops;
possible use of artificial light; 3 max
- [5]
- taste may vary from year to year; 2 max
- [6]
7. Award [1] for each of the following structures clearly drawn and labelled correctly.
- petals;
sepal;
stigma;
style;
ovary;
stamen / anther and filament;
receptacle / nectary;
- [6]

8. xerophytes are adapted to reduced availability of water / deserts;
hydrophytes are adapted to living in / on water (*reject high rainfall*);
named example of each;
- xerophytes have small leaves / no leaves / spines and hydrophytes have large
(floating) leaves / finely divided (submerged) leaves (*accept suitable drawing*);
xerophytes have reduced stomata and hydrophytes have no stomata on submerged
leaves / stomata on upper surface only of floating leaves;
xerophytes have a thick waxy cuticle and hydrophytes have little or no cuticle;
xerophytes have extensive / deep root systems and hydrophytes have reduced /
absent roots;
- xerophytes have hairs (to reflect sunlight), hydrophytes do not;
hydrophytes have tissues with airspaces, xerophytes do not;
xerophytes can be CAM / C₄, hydrophytes can not;
xerophytes have water storage tissues, hydrophytes do not;
- [8]
9. transported in xylem (vessels);
passive / no energy used by plants;
evaporation / transpiration causes low pressure / suction / pull;
transpiration stream / continuous column of water from roots to leaves;
water molecules are cohesive (so transmit the pull) / hydrogen bonding;
root pressure can move water up the plant;
apoplastic pathway is through cell walls;
- 4 max
- (Plus up to [2] for quality)
- [4]
10. (a) 6 (± 2) (%);
- 1
- (b) only ripe transcribe PG mRNA / ripe tomatoes produce more PG mRNA
than unripe;
band at 1.77 kb only in ripe;
- 2 max
- (c) no effect on unripe fruit;
band at 1.77 kb much smaller in transformed / less PG mRNA produced in
transformed ripe fruit;
antisense mRNA combines with sense mRNA;
inactivating the translation / less translation;
less PG to solubilize pectin of wall;
fruit takes longer to ripen;
- 3 max
- [6]

11. (a) plowing / transport / food / fur / skins / pets / zoos / seeing eyes dogs / other valid example; 1
- (b) (i) crosses between plants of different species (e.g. modern wheats); 1
- (ii) named example (e.g. tomato, wheat, sugar beet, bagworm moth);
alteration of number of chromosomes (euploidy) / three (or more) sets of chromosomes;
larger nuclei / larger cells;
larger organisms / more vigorous;
(generally) infertile;
allopolyploidy when of different species; 2 max
- [4]
12. water culture / no soil;
roots on polyethene / plastic tubes / vermiculite;
salts added / nutrient solution / any named nutrient solution (e.g. Sachs) / fertilizer;
greater control of environment;
yield increased; [3]
13. selection of suitable meristem (explant) / stem segment / bud / single cell;
sterilization (in sodium hypochlorite solution or other disinfectant);
transfer to nutrient (basal) medium / solidified agar;
medium contains salts (nitrates) / sugars / amino acids / vitamins;
(when buds elongate) transferred to multiplication medium;
promotes elongation / contains IAA (indole acetic acid);
growth promotion / mitosis stimulated / contains cytokinin / kinetin;
callus formed (if cytokinins low);
cloning / sub-culturing;
rooting medium / root development / IAA, IBA, NAA;
potted (in compost); [7]
14. (a) there is little difference between the treatments up to 16 mg / there are slightly less eggs laid in the 8 mg and 16 mg treatments with pheromone / both treatments produce about 90 eggs per plant up to 16 mg pheromone;
there are a lot less eggs laid when 32 mg of pheromone are used than without the pheromone; 2 max
- (b) the alarm pheromone could be used to warn other aphids to hide from predators;
to frighten off predators / competitors; 1 max
Any other suitable suggestion
Do not accept "to repel another pest species"
(given in the stem of the question).

- (c) 32 million aphids; 1
- (d) cabbage root fly do reduce their egg laying in the presence of the aphid pheromone; however, large amounts are require to have an effect; so many aphids would be needed on the plants they would cause serious damage to the plants; the use of peach-potato aphid to control the cabbage root fly would not be very effective; 3 max [7]
15. (a) plant growth regulators are hormones, fertilizers are mineral nutrients; plant growth regulators control growth / development, fertilizers are essential nutrients for healthy plant growth; plant growth regulators are released by tissues of the plants (in small quantities), fertilizers are absorbed from the soil (or by leaves); 2 max
- (b) individual plant cells / small clusters of tissue cells may be used; cultured on agar using aseptic techniques; growth encouraged by mixture of nutrients and plant growth regulators; undifferentiated callus forms which can be cut up again; a different mixture of plant growth regulators used to produce differentiated tissues; grown up to be adult plant which is a clone of the parent plant; an infinite number of identical plants can be produced this way; 3 max
- (c) pruning removes the apical regions of the shoots; therefore removing a source of auxin; apical dominance is lost; lateral shoots elongate / grow longer; plant becomes bushy; 2 max [7]
16. (a) breeding between two distantly related / genetically unrelated members of a species; breeding which promotes heterozygosity; 1 max
- (b) *maintaining biodiveristy of wild plants:*
 domesticated plants have been created from only a few species;
 environments change / new diseases appear / new areas may be cultivated;
 wild species may be more effective producers;
 wild species may be more tolerant to disease / climatic stress / other named factor;
 transgenic organisms may be created using genes from wild organisms;
 hybrids may be created by crossing with wild organisms;
- maintaining ancient farm breeds:*
 domesticated species of animals show restricted genetic variation;
 environments change / new diseases appear / new areas may be cultivated;
 ancient breeds may be more effective;
 ancient breeds may be more tolerant;
 transgenic organisms may be created using genes from ancient organisms;
 hybrids may be created by crossing with ancient farm breeds; 3 max [4]

17. C [1]
18. (a) citrate; 1
- (b) mitochondria (used in Krebs cycle); 1
- (c) root tissue includes all the organelles / the cytoplasm / all metabolic acids of all the cells / more concentrated;
the secreted acids are less / only those for complexing with Al^{3+} / in response to Al^{3+} / stress;
not all acids secreted / acids needed for Krebs cycle; 1 max
- (d) *Any other suitable suggestions; must mention **both** colours for full marks*
for pink flowers: non-acid soil / minimize / neutralize acidity of soil;
add organic acids to the soil to complex with Al^{3+} to have only pink flowers;
for blue flowers: add acid for more Al^{3+} ions / add Al^{3+} ions to the soil;
excess Al^{3+} could cause problems of H_2O and nutrient uptake;
genetic manipulation to decrease citrate / organic acid production / secretion; 3 max
- [6]
19. (a) *Award [1] for each comparison of organic **and** non-organic.*
use of natural fertilizers versus synthetic / chemical fertilizers;
biological pest control versus synthetic / chemical pesticides;
less long term contamination of environment versus more long-term contamination;
crop rotation versus more intensive / monoculture;
Award [0] for ethical issues. 2 max
- (b) *Answers must mention **both** for full marks.*
growth regulators are plant growth hormones / chemical messengers
(that stimulate (or inhibit) plant growth);
fertilizers are minerals (necessary for plant growth); 2 max
- [4]
20. vegetative propagation / a part of parent plant produces a new plant;
produce uniform quality of products / propagate the best plants;
genetic uniformity / no variety;
only mitosis / no meiosis;
rapid reproduction / many from one parent / shorter early stages of growth;
runners / lateral stems / rhizomes;
e.g. strawberries / other valid example;
cuttings that are rooted;
grafting shoot of one plant to roots of other;
e.g. fruit trees / other valid example;
tubers / bulbs / underground rhizomes / perennating organs
survive in soil over winter;
e.g. tulip / iris / other valid example;
micropropagation of meristematic cells on nutrient agar / tissue culture;
e.g. African violets / other valid example;
disadvantage of genetic uniformity and susceptibility to disease / change; [6]
21. (a) greatest in alfalfa but lowest in Sudan;
saltbush and sea blite higher than Sudan, lower than alfalfa;

seawater average / total biomass is higher than the freshwater (*could be a numerical comparison*);

no overall trend / no difference;

2 max

- (b) greater daily weight gain in sea blite / 110 %, less in saltbush / 90 %;
greater water intake in sea blite / 190 %, less in saltbush / 145 %;

2

- (c) *Must have both advantages and disadvantages for full marks.*

advantages:

good biomass yield;

good daily weight gain of sheep;

(slight) improvement in meat quality;

avoids using freshwater;

disadvantages:

lower food conversion efficiency;

greater water intake by sheep;

3 max

[7]

22. (a) food;
plowing;
transport;
fur / clothes / skins / wool;
sheepdogs;
guide dogs;
pets;
vaccines;
medical trials;

2 max

Accept other appropriate examples.

- (b) (i) obtaining more vigorous offspring by crossing unrelated varieties
The answer requires more than just a definition of a hybrid.

1

- (ii) different rice varieties collected / assessed;
varieties with desired characteristics bred;
cross pollination;
grown on and best ones chosen;
seed saved;

example:

IR8;

semi-dwarf variety (of Taiwan) crossed with fast
growing (from Indonesia);

new variety with short stem and heavy ears of large grain;

3 max

[6]

23. (a) apical dominance / growth promoter;
induction of fruit development (even if no fertilization);
root formation;
phototropism;

2 max

- (b) warmer temperatures for enzymes / glass or plastic retains long wave radiation;
 more carbon dioxide for photosynthesis / burning of fuel to increase CO₂;
 more light for photosynthesis / artificial lighting;
 high water availability / irrigation;
 ventilation to increase transpiration rate;
 exclusion of predators;
 shade to avoid excess of light;
 damage due to storm avoided; 3 max [5]
24. (a) cotton / banana / flax / nettle 1
- (b) more sustainable / less harmful to environment;
 organic uses biological control;
 mineral bearing rocks added;
 relies on crop rotation;
 animal manure as fertilizer;
 no artificial fertilizers;
 less productive;
 crop residues as fertilizers;
 mechanical cultivation;
 more diseased crops / animals;
 excludes pesticides / growth regulators / feed additives; 3 max
- (c) no soil needed;
 plants grown in water/sand;
 nutrients added to water
 needs less space;
 plants can be grown in places where could not normally / inside homes;
 bigger yields / more yields per year;
 can be grown out of season; 3 max [7]
25. (a) animals are less likely to catch diseases so bigger yield / grow faster;
 may lead to antibiotic resistance in humans / animals; 2
- (b) pruning involves cutting parts from the plant;
 apical dominance occurs when most growth is at the apex (end bud);
 this growth is stimulated by auxins;
 auxin concentration is too high for/inhibits lateral bud growth;
 removal of the apex causes a fall in auxin concentration;
 lateral buds can then grow / this makes a bushier plant;
 makes cuttings available for extra plants; 3 max [5]
26. C [1]
27. B [1]

28. Award [1] for each of the following structures, shown in the correct relative position and labelled. Individual cells are not needed but do not penalize if they are shown.
- upper epidermis;
 - palisade layer / mesophyll;
 - spongy layer / mesophyll;
 - lower epidermis;
 - xylem (in a major or minor vein);
 - phloem (in a major or minor vein);
 - collenchyma (in the midrib);
 - guard cells; (do not accept stoma/stomata only)

[6]

29. Award up to [2 max] for the difference between the plants.

xerophytes:

adapted to arid / dry climates / deserts;

hydrophytes:

adapted to grow submerged in water / floating on water;

Reject "grows in wet areas " or "needs lots of water".

Award [1] for any one of the following structural adaptations in xerophytes.

small thick leaves / spines / water storage in leaves;

thick waxy cuticle;

thick stems / water storage in stems;

stomata concentrated on lower epidermis;

stomata in pits / surrounded by hairs;

deep roots / wide-spreading shallow roots;

Award [1] for any one of the following structural adaptations in hydrophytes.

air spaces in leaves/stems;

wax cuticle on upper epidermis but not on lower epidermis;

stomata on upper epidermis but not on lower epidermis;

"breathing" roots / reduced roots;

pliable parts with little strengthening tissue;

finely divided submerged leaves;

(Plus up to [2] for quality)

4 max

[4]

30. (a) in Brigadier and Packman, glucoraphanin higher in concentration than progoitrin; progoitrin approximately equal in Packman and Brigadier / greatest in Petro; Brigadier has highest total glucosinolate concentration; Brigadier has highest glucoraphanin concentration; Packman has lowest total glucosinolate concentration; Packman has lowest glucoraphanin concentration; 3 max
- (b) (outbreeding is) reproduction involving fusion of gametes produced by genetically unrelated individuals; can increase aliphatic glucosinolate concentration because more variation is due to genetic factors; Brigadier and Petro have more aliphatic glucosinolates; cross Brigadier with Petro; because Brigadier has more glucoraphanin and Petro has more progoitrin; 3 max

[6]

31. (a) vigour / increase in desirable qualities (e.g. growth rate, yield, fertility) due to high levels of heterozygosity

1

- (b) yield per unit area increases / less land required;
health of animals can be monitored;
cost per worker is lower / more efficient production;
quality of meat/food / desired characteristics can be better;
better control over reproduction;

3 max

[4]

32. reservoir of genetic diversity / prevents inbreeding / prevents homozygosity;
more suited to local conditions;
may carry alleles for future needs;
may contain genes for medicinal products;
can be bred to give newer varieties;
hybrid vigour may combine genes for insect resistance/beneficial characteristics;

[4]

33. *Responses must have at least two arguments for and two arguments against to receive full marks.*

arguments for:

transgenic plants do not survive long in wild;
reduced cost of food production / reduce amount of land used for food production;
transfer of genes occurs naturally;
DNA and proteins are digested (unlikely to cause problems);
longer shelf life for certain products;
increased yield / bred for faster growth;
better adaptation to certain conditions / eliminate possible plagues;
healthier food produced because use of pesticides can be decreased *e.g.* Bt corn /
increase food quality *e.g.* albumin gene has increased sulfur amino acid content of
alfalfa used to feed sheep;

arguments against:

uncertain long-term health effects from eating transgenic crops / may contain
animal genes;
new proteins in food crops could cause allergies;
genes could escape from transgenics to wild plants;
create superweeds / damage ecosystems;
monopoly (created by large companies) adversely affects small farmers;

[6]

34. (a) when a shoot is illuminated from one side;
auxin is transported laterally to the other side;
where it causes greater growth on one / dark side;
by stimulating cell elongation;

3 max

- (b) gibberellic acid is normally produced by the seeds;
GA makes the fruit develop;
artificial spraying of GA;
means the fruit can develop independent of the need for seeds;

2 max

[5]

35. (a) Award [1] for each of the structures correctly drawn and labelled.
Grass or other suitable monocotyledonous wind pollinated example required.
 stigma labelled and drawn feathery;
 stigma drawn protruding;
 perianth / bracts reduced / labelled reduced;
 filaments elongated in drawing / labelled elongated;
 anthers labelled and shown protruding from the flower / exposed to wind; [4]
36. some flowering plants are short-day plants;
 others are long-day plants;
 important variable is length of darkness / photoperiod;
 some plants grown in greenhouses with controlled light conditions;
 short-day plants kept in the dark during daylight hours;
 long-day plants artificially lit during the night;
 using an appropriate wavelength / far-red light / 730 nm;
 possible to expose only for brief periods to keep costs down
 but long enough to interrupt the dark period;
 involves interaction of phytochromes with metabolic reactions;
 controlled by the plant's biological clock; [6]
37. (a) (i) greenhouse / T 1
 (ii) shaded / reduced light / L 1
 (b) adding nutrients / raising temperature increased biomass (compared to control);
 more shading decreased biomass (compared to control);
 nutrients cause greatest increase in biomass; 2 max
Accept numerical answers.
 (c) adding nutrients increase deciduous biomass so soil deficient in nutrients /
 nutrients were limiting factor (for deciduous plants);
 shading decreases biomass as light is a limiting factor for all plants (except lichens);
 nutrients and increased temperature increase deciduous plants which out-compete
 the others;
 increased temperature decreases overall biomass / plants are adapted to arctic
 temperatures;
 mosses are best adapted to control / arctic conditions; 2 max
Any other valid reasons. [6]
38. (a) important source of genetic diversity;
 future value / as reservoir of alleles / in medicine / other; 2 max
 many better adapted to local / changing conditions;
 (b) Responses must give one technique and state how it improves health to
 receive full marks.
e.g. vaccinations;
 to prevent disease;
e.g. nutrient supplements;
 to prevent nutritional deficiencies / to promote better growth; 2 max [4]
39. (a) a plant growth promotor / regulator / hormone;
 act in phototropism;

causes cell elongation / bending on side away from light;
 produced in shoot tips / apical dominance;
 prevents lateral growth;
 cutting / pruning shoot tips causes bushy growth; 3 max

(b) (i) nutrients depletion;
 pest invasions; 1 max

(ii) *organic: 2 max*
 avoids artificial / synthetic fertilizer / pesticides / growth regulators /
 feed additives;
 uses crop rotation / mechanical cultivation;
 crop residues / animal manure / natural minerals as fertilizers;
 biological pest control;
non-organic: 2 max
 uses artificial / synthetic fertilizer / pesticides / growth regulators / feed additives;
 more efficient for use of pesticides / synthetic fertilizers specific to conditions;
 may cause environmental pollution;
 often monocultures that deplete soil nutrients;
 Award [0] for ethical issues. 4 max

[8]

40. A

[1]

41. C

[1]

42.

<i>bryophytes</i>	<i>angiospermophytes</i>
non-vascular / no xylem	vascular / xylem;
seedless	seeds;
gametophyte dominant generation	sporophyte dominant generation;
no flowers	flowering;
no true leaves / stems	true leaves / stems;
rhizoids	roots;
no cuticle	cuticle;
no fruits	fruits;
motile sperm / male gamete	pollen;

[5]

43. To receive full marks responses must address all three parts.

light: [2 max]

causes stomatal opening in morning, increasing transpiration;
increasing light increases transpiration;
because stomatal opening increases;
no light causes stomatal closure, reducing transpiration;

wind: [3 max]

removes water / vapour from around leaf;
increases water vapour / humidity gradient so increases transpiration;
increases transpiration / lack of wind can reduce transpiration;
no increase in transpiration if humidity is 100 %;

humidity : [3 max]

high humidity reduces water vapour gradient so lowers transpiration;
high humidity lowers transpiration rate;
lowering humidity can increase transpiration rate (to a point);
at very low humidity stomata may shut down;

[8]

44. absorption of water;
gibberellic acid produced in embryo;
stimulates production of amylase;
catalyses the breakdown of starch to maltose;
maltose diffuses to embryo;
used for energy production and growth;
(Plus up to [2] for quality)

5 max

[5]

45. (a) $0.29 (\pm 0.01) \mu\text{mol maltose min}^{-1}$ (units needed)

1

(b) no substantial increase in activity in the 20 % treatment over the five days of the experiment / 30 % sample reaches maximum activity two days after start of treatment;
higher level of activity at all times for 30 % treatment compared with 20 % treatment;
activity approximately six times higher for 30 % treatment than for 20 % treatment on day two;
any other appropriate numerical example;

2 max

(c) 30 % treatment will have greater amount of free sugars (maltose) than 20 % treatment

1

(d) water stress will trigger synthesis of proteins / β -amylase;
maltose and other free sugars attract water so will reduce the effect of water stress;
maltose and other free sugars may prevent water loss (by osmosis);
starch exerts less osmotic pressure / solute potential than free sugars;
30 % PEG creates an optimum environment for β -amylase activity;

2 max

[6]

46. (a) mass of plant dry weight / wet weight / fresh weight / harvestable biomass;
biomass per unit area of cultivated land;
relative growth rate;
net assimilation rate;

2 max

- (b) CO₂ can limit rate of photosynthesis (at high light intensity and high temperature);
 increasing CO₂ concentration increases plant growth (up to a certain point);
 increasing CO₂ concentration increases carbon fixation / Calvin cycle; 2 max

[4]

47. small piece of plant removed;
 tissue is placed on sterile nutrient agar gel containing high auxin concentration;
 callus growth / tissue cut into smaller pieces with same treatment;
 callus growth / tissue is transferred to agar gel containing cytokinin;
 gibberellin is sometimes added;
 plantlets are separated and transferred to soil;

[4]

48. (a) (i) net increase in plant biomass per unit
 area of leaf per unit time 1

- (ii) measure mass of equivalent amounts of plants at
 start and end of growth period;
 harvest plants from a given area, removing and
 measuring area of all leaves; 1 max

- (b) control of temperatures / warmer conditions;
 control of CO₂ concentrations / CO₂ levels increased;
 increase light levels / use of artificial lights;
 control water/irrigation / high humidity;
 control predators / disease;
 control of nutrients/fertilizer addition;
 regulate soil composition / hydroponics;
 protect against extreme weather conditions
 (e.g. hail / gales) 4 max

[6]

49. (a) (i) 8 ppm (units required) 1
 (ii) 44 (± 2) 1

- (b) with increasing concentration of extract growth stimulation turns
 into growth inhibition / *vice versa*;
 concentrations of 0.16 and 8 ppm have a growth stimulating
 effect of 13%, 18% respectively, ± 1 on figures;
 at 40 and 200 ppm extract shows 18 % and 48 % growth inhibition
 respectively, ± 1 on figures;
 five fold increase of extract (40 to 200 ppm)
 does not lead to a five fold increase in growth inhibition; 2 max
 fifty fold increase in extract (0.16 to 8 ppm) does not
 have a noticeable/significant effect on the growth stimulation;

- (c) light might break down the extract;
 light might activate the extract;
 darkness may lengthen the activity period;
 find out when it works best;
 light may stimulate reaction between extract and seedling;
 light may inhibit reaction between extract and seedlings; 2 max

[6]

50. (a) Answers must refer to both biological and chemical control in order to

receive full marks.

biological: [2 max]

predator/parasite/pathogen may damage ecosystems by attacking other organisms apart from the pest;
do not often work outside restricted area *e.g.* greenhouse;
can only be introduced when there is a pest /
some damage will be done before it can be introduced;
can become a pest itself;

chemical: [2 max]

may cause health problems;
resistance;
non-target species;
accumulation year on year;
water / air pollution;
accumulation in food(s);
long-term effects;
non bio-degradable;

4 max

- (b) antibiotics increase growth rates by controlling infection;
can boost production of milk and meat so more food available;
less illness / suffering in animals;
allow high density / intensive farming;
increase in antibiotic resistant strains of bacteria;
antibiotics may harm human health and the environment;

3 max

[7]

51. (a) *Answers must refer to both regulators and fertilizers to obtain full marks.*

plant growth regulators: [1 max]

chemical substances that act as messengers;
control growth and development in plants;
some are hormones / auxins;

fertilizers: [1 max]

minerals;
For healthy growth / accept named
example *e.g.* nitrogen for growth

2 max

- (b) shoots of plants grow towards light / positively phototropic;
roots grow away from light / regularly phototropic;
shoot tips produce auxin;
acts as a growth promoter /
promotes secretion of hydrogen ions into cell walls;
loosens connections between cellulose fibres;
allows cell expansion;
is distributed in the tip from the lighter to the darker side;
plant bends towards the light;

3 max

[5]

52. B

[1]

53. C

[1]

54. (a) blood carries heat;
skin arterioles carry blood to skin surface / capillary beds;
body temperature high, vasodilation occurs/arterioles dilate;
increasing heat loss to the environment / cooling blood;
body temperature low, vasoconstriction
occurs/arterioles become narrower;
decreasing heat loss to the environment/conserving heat; 3 max

(b) transpiration is the loss of water vapour
from stems and leaves/plant;
high temperature favours transpiration /
low temperature decreases transpiration;
high temperature increases evaporation of
water (from the surface of plant cells);
high temperature increases motion of water
molecules/ rate of diffusion of water
(out of stomata);
humidity influences the effect of temperature on transpiration; 3 max

(c) enzymes have an optimum temperature;
increase in temperature increases motion/energy of)
enzyme and substrate molecules;)
increased frequency of contact between substrate and) (Accept converse i.e. effect
active sites;) of lowering temperature)
reaction rate increases;)

high temperature disrupts intermolecular forces /
denatures enzymes; 3 max

[9]

55. roots have a large / increased surface area (in relation to their volume);
root hairs increase the surface area;
water is absorbed by osmosis;
solute concentration inside the root is higher than in the soil / outside;
due to active transport of ion into the root;
apoplastic and symplastic transport across root;
apoplastic route is through the cell walls (and intercellular spaces);
symplastic route is through the cytoplasm (and plasmodesmata);
carried up stem by xylem (vessel elements/tracheids);
water has to pass through cytoplasm of endodermis /
Casparian strip blocks water;
water movement in xylem due to pulling force /
transpiration pull from leaves;
cohesion between water molecules;

[8]

56. *bryophytes*:
 non-vascular/no true roots/rhizoids /
 dominant gametophyte / dependent sporophyte;
angiospermophytes:
 flowering / seeds encased in fruits;
coniferophytes:
 naked seeds / cone bearing;
- [3]
57. name of dicotyledonous plant;
 Do not accept tree, pondweed, any monocots, conifers, ferns.
 Award [1] for each of the following structures clearly
drawn and correctly labelled, up to [4 max].
root / roots; (Shown forming a branching network joined to the stem.)
stem / stems;
leaf / leaves;
axillary bud drawn in leaf axil;
terminal bud drawn at tip of stem;
flower / inflorescence / named part of flower;
- [5]
58. roots have a large/increased surface area (in relation to their volume);
 branching/lateral roots (increases the surface area);
 root hairs increase the surface area;
 cortex cell walls (increase the surface area);
 water is absorbed by osmosis;
 solute concentration inside the root is higher than in the soil / outside;
 due to active transport of ions into the root;
 apoplastic and symplastic transport across the root;
 apoplastic route is through the cell walls (and intercellular spaces);
 symplastic route is through the cytoplasm (and plasmodesmata);
 water has to pass through cytoplasm of endodermis / Casparian strip blocks walls;
 water movement in xylem due to pulling force / transpiration pull;
 cohesion between water molecules;
- [9]
59. (a) *Vitellaria paradoxa* 1
 (b) construction 1
 (c) 3 species / *A. digitata*, *P. biglobosa*, *V. doniana*
 "very important" in both categories;
 10 species ranked "very important" for edible
 fruits and 7 species for vegetable sauce;
 overall the 20 tree species were slightly more valuable
 for edible fruits than for vegetable sauce;
Ximenia africana more useful as edible
 fruit but not as vegetable sauce / *vice versa* for *Bombax costatum*;
 in both categories there were no "do not know" responses; 2 max

(d) $\frac{3}{20} \times 100 = 15\%$

Do not need to show working 1

- (e) strength;
resistance to insect attack *e.g.* termites;
attractiveness;
resistant to decay;
flexible;
not too heavy;
easy to cut;
tradition; 1 max

[6]

60. (a) large / colorful petals;
petals release scent;
nectaries secrete nectar;
sticky pollen grains;
sturdy filaments to hold anthers in position when brushed; 2 max
- (b) net increase in plant biomass per unit area of leaf per unit time 1
- (c) it will not flower/bloom 1

[4]

61. *positive aspects:*
monoculture involves planting and raising only one type of crop;
however, crop selection dependent on local climate,
soil and amount of land;
one crop allows for one type of harvesting technique;
predictable harvest time;
requires less variety of equipment/less expense in harvesting;
specialization allows for greater overall efficiency;
resulting in more profit per unit of biomass/per unit of land;
farmer can choose the crop that seems to be the most profitable;
pesticides / fungicides / herbicides must be applied at correct time;

negative aspects:
monoculture often requires use of fertilizers;
fertilizers are expensive / contaminate;
pesticides are often required to protect crop against specific insects;
single type of crop can be eliminated by disease;
farmers with one crop are more vulnerable to price
changes on domestic/world markets;
genetic variability of crop has been compromised;

[7]

*For full marks answer must include at least one positive aspect
and one negative aspect. Award [6 max] if only one aspect
presented.*

62. (a) (i) bromoxynil 1
- (ii) allinol 1
- (iii) 47 (%) 1
- (b) surfactants may help some herbicides in weed control;
no effect of surfactant when using bromoxynil;

surfactant helped with 2,4-D and glyphosphate;
all surfactants helped equally with 2,4-D;
glyphosphate was helped with by MON 0818 and oxysorbic;
allinol interferes with/reduces effect of glyphosphate (herbicide);

3 max

[6]

63. flowering in LDP controlled by the plant's biological clock;
uses phytochrome to measure dark period /
Pr converted to Pfr during daylight;
LDP needs a day length longer than a critical period /
night length shorter than a critical period;
Pfr remains at the end of short nights;
Pfr stimulates flowering;
flowering hormone / florigen released;
phytochrome system / biological clock located in leaf;
example of LDP;

[4]

64. *arguments for: [4 max]*

either/both can increase yields in crops /
reduces famine/starvation in same areas;
pesticides can kill organisms that transmit diseases;
biological controls are safer for health and environment;
either/both costs may be reduced for the farmer;
either/both can be very specific with respect to the pest;

arguments against: [4 max]

biological controls can harm ecosystem introducing alien organisms;
pesticide residues may be in food / water consumed by humans;
pests may develop resistance to pesticides;
non-target species may be harmed;
workers may suffer health problems when using pesticides;
pesticides can move through food chain harming top carnivores /
birds of prey;

[6]