Chapter 9 - Plant Biology *[242 marks]*

1. How do auxins cause plant shoots to grow towards light? *[1 mark]*
   A. Increase cell division on the side of the stem near the light source
   B. Increase cell division on the side of the stem away from the light source
   C. Increase cell elongation on the side of the stem near the light source
   D. Increase cell elongation on the side of the stem away from the light source

Markscheme

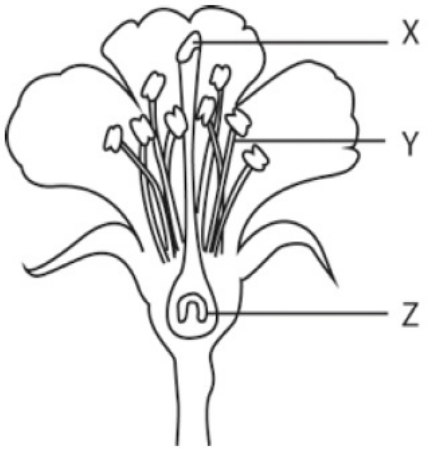
D

2. What is transported in xylem tissue? *[1 mark]*
   A. Sucrose from leaves to fruits
   B. Starch from leaves to storage organs
   C. Water from roots to leaves
   D. Salts from soil to roots

Markscheme

C

3. The following is a diagram of a flower. *[1 mark]*



[Source: © International Baccalaureate Organization 2014]

What structures are indicated by the letters X, Y and Z?

	X	Y	Z
A.	stigma	style	sepal
B.	anther	style	ovary
C.	stigma	filament	ovary
D.	anther	filament	ovary

Markscheme

C

4. What steps occur in germination after water uptake? *[1 mark]*

A. Gibberellin is produced, followed by amylase activation
B. Gibberellin stimulates photosynthesis to begin in the cotyledons
C. Amylase breaks down starch to glucose which activates the embryo
D. Amylase synthesis followed by activation of gibberellin

Markscheme

A

5. Which abiotic factors affect transpiration in plants? *[1 mark]*

A. temperature, humidity and wind
B. pH, temperature and salinity
C. light, pH and humidity
D. humidity, temperature and salinity

Markscheme

A

6. Which process happens first during germination of a starchy seed? *[1 mark]*

A. Formation of gibberellin
B. Production of amylase
C. Absorption of water
D. Conversion of starch into monosaccharides

Markscheme

C

7. A man attaches a bird box to the trunk of a dicotyledonous tree. A few years later he returns to the tree and finds that his bird box is still attached and the tree is much taller. How high will his bird box be from the ground? *[1 mark]*

A. Unchanged as growth from the apical meristem would be above the box.
B. Unchanged as growth from the lateral meristem would be above the box.
C. Higher as growth from the apical meristem would be below the box.
D. Higher as growth from the lateral meristem would be below the box.

Markscheme

A

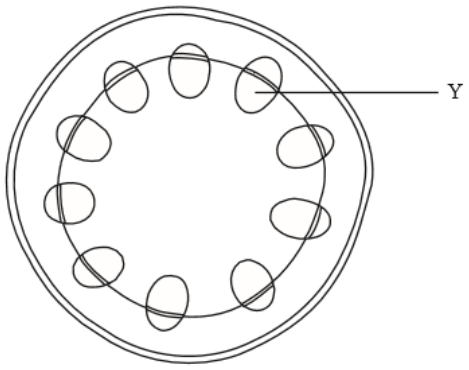
8. What is a role of xylem? *[1 mark]*

A. It absorbs minerals from the soil by active transport.
B. It translocates amino acids from source to sink.
C. It carries glucose to the leaves.
D. It contributes to the plant support with lignified walls.

Markscheme

D

9. The diagram below shows a cross section of a stem. What is the structure labelled Y and one of its functions? *[1 mark]*

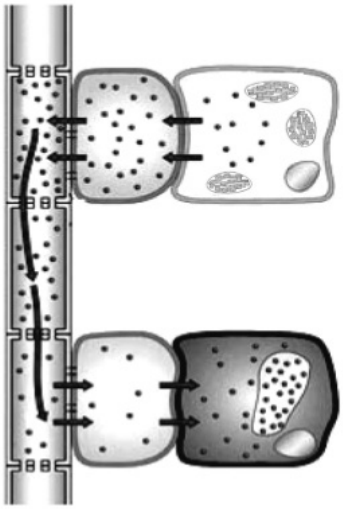


	Structure Y	Function
A.	phloem	storage of water and starch
B.	xylem	mechanical support
C.	phloem	gas exchange
D.	xylem	transport of sugars

Markscheme

B

10. The diagram below shows part of the vascular system of a dicotyledonous plant. Which process is indicated by the arrows? *[1 mark]*



[Source: adapted from http://www.uic.edu/classes/bios/bios100/lectf03am/translocation.jpg]

A. Passive translocation of sucrose from the sink to the source in the phloem
B. Active translocation of sucrose from the source to the sink in the phloem
C. Passive translocation of sucrose from the sink to the source in the xylem
D. Active translocation of sucrose from the source to the sink in the xylem

Markscheme

B

11. How do mineral ions in the soil move into the root? *[1 mark]*

A. Osmosis
B. Mass flow of water
C. Translocation
D. Through phloem

Markscheme

B

12. Angiospermophyta have vascular tissue (xylem and phloem) that bryophyta lack. Suggest advantages that vascular tissue confers. *[3 marks]*

Markscheme

would make it easier to stand upright (against gravity)/structural support / allows (angiospermophytes) to be bigger;
could put leaves higher in the air to get more sunlight;
transport of water supply/nutrients from roots to other tissues;
could (more efficiently) transport/translocate sugars/food from leaves for storage;

13a. State which variety of rice fails to respond to gibberellin treatment. *[1 mark]*

Markscheme

gid1-1

13b. The activity of α-amylase was tested at successive concentrations of gibberellin. Determine the increment in gibberellin concentration that produces the greatest change in α-amylase activity in wild-type rice plants (WT). *[1 mark]*

Markscheme

between 10^{-8} and 10^{-7} mol dm^{-3} *(units required)*

13c. Discuss the consequence of crossing *gid1-1* heterozygous rice plants amongst themselves for food production. *[3 marks]*

Markscheme

a. 25% / 1 in 4 / 1:3 seeds produced would be homozygous recessive;

b. no response to/inhibits gibberellin in homozygous recessives results in less germination;

c. less growth / dwarf plants produced; *(must be in context)*;

d. would produce plants with infertile flowers that cannot produce rice grains;

e. would lower rice production/less yield because infertile plants cannot produce seeds (that humans can eat);

13d. Determine which gene produced the most mRNA on the first day of the submergence period for variety *O. sativa japonica*. *[1 mark]*

Markscheme

Sub1C

13e. Outline the difference in mRNA production for the three genes during the submergence period for variety *O. sativa indica*. *[2 marks]*

Markscheme

a. *Sub1A* is expressed strongly/the most / *Sub1A* produces the most RNA;

b. *Sub1B* (always) has the lowest expression/produces least mRNA;

c. *Sub1A* expressed/produces mRNA for the longest time/days 1 to 10;

d. *Sub1C* expressed/produces mRNA for the shortest time/days 3 to 7;

13f. Using only this data, deduce which gene confers submersion resistance to rice plants. *[2 marks]*

Markscheme

a. *Sub1A*;

b. is only expressed in *indica* / *Sub1B* and *SubC* are expressed in both rice varieties;

c. *indica* is the variety showing submersion tolerance / vice versa for *japonica*;

13g. State the overall effect of overexpression of the *OsGI* gene in plants treated with short-day light. *[1 mark]*

Markscheme

it increases the length of time before flowering

13h. Compare the results between the plants treated with short-day light and the plants treated with long-day light. *[2 marks]*

Markscheme

a. long-day light exposure increases time before flowering only if (*OsGI*) gene is not overexpressed/in WT and –/–;

b. long-day light exposure decreases time before flowering for +/– and/or +/+;

c. length of day does not make much difference/makes least difference for +/+;

d. overexpression for +/– reduces time before flowering;

e. –/– acts as a control / has nearly the same length of time before flowering as WT;

Accept numerical answers if they are making a clear comparison.

13i. State, giving **one** reason taken from the data opposite, if unmodified rice is a short-day plant **or** a long-day plant. *[1 mark]*

Markscheme

is a short-day plant because WT has shortest time/shorter time before flowering in shorter days than longer days / as it takes less time to flower under short day conditions;

13j. Evaluate, using all the data, how modified varieties of rice could be used to overcome food shortages in some countries. *[2 marks]*

Markscheme

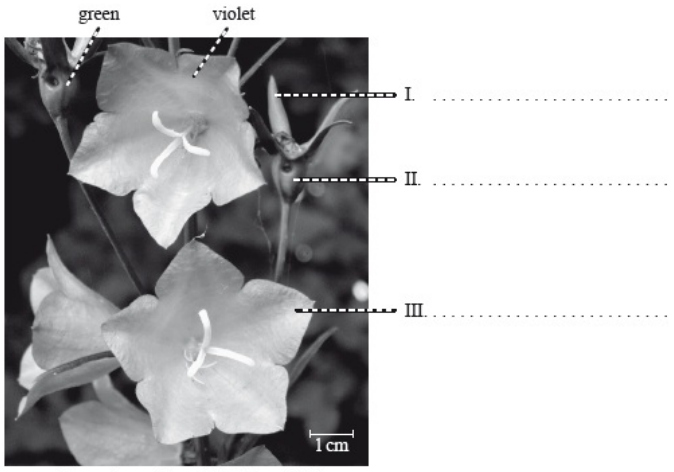
a. the mutant *gid1-1* would not be useful because it produces sterile plants;

b. genetically modified rice/rice with *Sub1A* is more tolerant to submersion/can withstand seasonal flooding/torrential rain;

c. *OsGI*+ varieties adapted to different latitudes / day length could be produced (to overcome food shortages);

d. short flowering time possibly means more crops per year;

14a. The photograph below shows the flowers of *Campanula persicifolia*. Label structures I, II and III. *[3 marks]*



[Source: photograph provided by IB examiner]

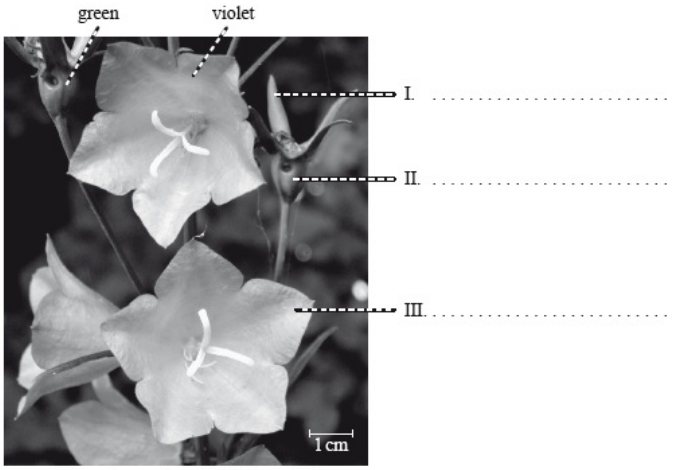
Markscheme

I. sepal;

II. ovary / receptacle;

III. petal;

14b. *[1 mark]*



[Source: photograph provided by IB examiner]

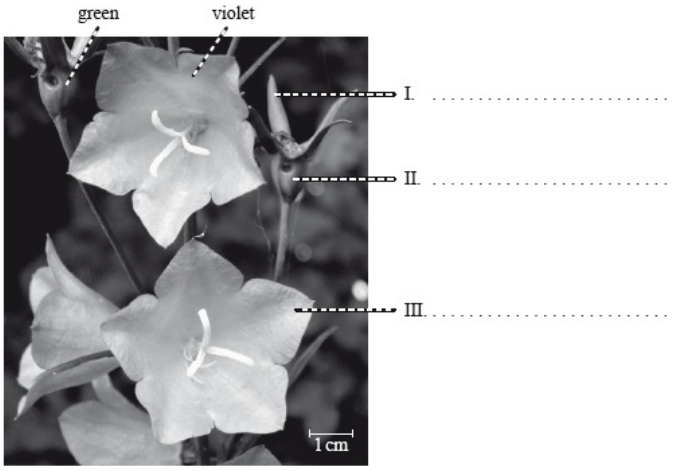
Using the external features shown in the photograph, state the phylum to which this plant belongs.

Markscheme

Angiospermophyta / Angiospermophytes / Angiosperms

Do not accept flowering plants.

14c. *[2 marks]*



[Source: photograph provided by IB examiner]

Comment on the hypothesis that the plant shown in the photograph could be pollinated by an animal.

Markscheme

a. confirms the hypothesis;

b. stigma/anther inside the flower/ring of petals so as visiting animal enters it brushes past them;

c. colourful petals (provide contrast) so that flowers can be seen by animals;

d. (slightly) cone-shaped flowers so animals come in;

14d. Outline the use of the binomial system of nomenclature in *Campanula persicifolia*. *[2 marks]*

Markscheme

a. first name/*Campanula* for genus / second name/*persicifolia* for species;

b. (all) members of *Campanula persicifolia* share special/unique features;

c. two names make a unique combination to designate species / worldwide recognized nomenclature;

15a. Explain how abiotic factors affect the rate of transpiration in terrestrial plants. *[8 marks]*

Markscheme

a. less transpiration/water loss as (atmospheric) humidity rises;

b. air spaces inside leaf are saturated/nearly saturated (with water vapour);

c. smaller concentration gradient with higher atmospheric humidity;

d. more transpiration/water loss as temperature rises/with more heat;

e. faster diffusion / more kinetic energy (of water molecules);

f. faster evaporation (due to more latent heat available);

g. more transpiration/water loss as wind (speed) increases;

h. humid air/water vapour blown away from the leaf;

i. increasing the concentration gradient (of water vapour);

j. more transpiration/water loss in the light;

k. light causes stomata to open / stomata closed in darkness;

l. low CO_2 concentration inside leaf in bright light so stomata open wider;

Accept any of the points if clearly made on an annotated graph.

15b. Describe the importance of water to living organisms. *[5 marks]*

Markscheme

a. coolant in sweat/in transpiration;

b. water has a high heat of vaporisation / heat taken when hydrogen bonds break;

c. water is cohesive so can pulled up/so can be moved under tension in xylem;

d. water is an excellent/universal solvent/dissolves many different substances;

e. medium for transport in blood/xylem/phloem;

f. medium for metabolic reactions / (metabolic) reactions happen dissolved in water;

g. surface tension due to cohesion allows organisms to live on water surface;

h. water has high heat capacity so much energy required to change its temperature;

i. ice floats so lakes/oceans do not freeze allowing life under the ice;

j. high heat capacity so stable habitat/so temperature of water changes slowly;

k. used in chemical reactions/photosynthesis/hydrolysis in organisms;

16a. Explain how minerals move into plants. *[8 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. minerals bound to soil particles;
b. examples of three nutrients from: phosphate, nitrate, magnesium, iron, calcium, potassium, sodium, magnesium;
c. minerals dissolve in water;
d. mass flow causes movement of minerals with movement of water through soil;
e. minerals diffuse down a concentration gradient towards roots (as the mineral concentration next to the roots is continuously decreasing);
f. minerals enter the plant through roots;
g. by active transport / use of ATP;
h. branching of roots increases surface area for absorption of minerals;
i. root hairs increase surface area (for the absorption of minerals);
j. hypha of (mutualistic) fungi may enhance movement of selected ions into roots / increase surface area;
k. root hairs have many mitochondria to provide energy/ATP for active transport;
l. export of H+ creates electrochemical gradient / displaces ions bound to soil/clay;
m. that causes positive mineral ions to diffuse into (root) cells;
n. negative mineral ions cross membrane linked to H+ ions moving down (H+) gradient;

16b. Outline the conditions needed for the germination of a typical seed. *[3 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. water to rehydrate the seed / activate metabolic processes;
b. oxygen for aerobic respiration as seed germinates;
c. suitable temperature for enzyme activity;
d. each type of seed has specific temperature requirements / temperature requirements ensure that seeds germinate at the correct time of year;
Do not accept a simple list of factors without details.

16c. Following germination of seeds, plants undergo a rapid increase in the number of cells. Describe stages in the cell cycle that result in this increase of cells. *[7 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. growth phase/G-1: synthesis of proteins/cytoplasm/organelles;
b. synthesis phase/S-phase: replication of DNA;
c. second growth phase/G-2: continued growth of cytoplasm/molecular synthesis/duplication of organelles;
d. prophase: chromosomes super-coil to prepare for mitosis / nuclear envelope disappears / spindle fibres form;
e. metaphase: chromosomes line up at equatorial/metaphase plate / spindle fibres attach to centromeres/chromosomes;
f. anaphase: chromatids move along microtubules/spindle fibres move chromatids toward opposite poles;
g. telophase: nuclear membranes form around each cluster of chromosomes;
h. cytokinesis: new plasma membrane forms between the nuclei / cell plate forms;
i. a new cell wall forms;
j. (mitosis) results in two cells with identical nuclei;

Names of phases are required to earn the mark.
Award marks for a clearly drawn correctly annotated diagram.

17a. Outline the metabolic processes that occur in starchy seeds during germination. *[6 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. water absorbed by the seed / seed rehydrated;
b. water activates metabolism;
c. gibberellin synthesized/produced/secreted;
d. gibberellin stimulates the production of amylase;
e. amylase digests/hydrolyses starch to maltose;
f. maltose converted/hydrolysed to glucose (by maltase);
g. glucose used in aerobic respiration;
h. glucose used in synthesis/production of cellulose;

17b. Explain the light-independent processes of photosynthesis in plants. *[8 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. occurs in stroma (of chloroplast);
b. energy/ATP and NADPH provided by the light-dependent reactions;
c. Calvin cycle;
d. carbon dioxide fixed to RuBP / carboxylation of RuBP/ribulose bisphosphate;
e. by RuBP carboxylase/rubisco;
f. forms unstable 6C compound / forms 6C compound which splits;
g. glycerate 3-phosphate (is produced by carbon fixation);
h. (glycerate phosphate) to triose phosphate/3C sugar by reduction/adding hydrogen;
i. using NADPH/reduced NADP;
j. triose phosphate/3C sugar converted to form hexose/glucose (phosphate);
k. most/$^{5}/_{6}$ of triose phosphate used for regeneration of RuBP;
l. ATP used to regenerate RUBP/convert glycerate 3-phosphate to triose phosphate;

18a. Outline how and where energy is stored in plants. *[4 marks]*

Markscheme

a. glucose (from photosynthesis) stored as starch;
b. starch stored (as granules) in chloroplast/in plastids;
c. (starch stored) in seeds/storage roots/stem tubers;
d. stored as lipids/oils;
e. (lipid/oils storage) in seeds;
f. lipids store twice as much energy per gram as starch;

18b. Ecologists sometimes display data from an ecosystem using a diagram called a pyramid of energy. Describe what is shown in pyramids of energy. *[6 marks]*

Markscheme

a. pyramid of energy shows the flow of energy from one trophic level to the next (in a community);
b. units of pyramids of energy are energy per unit area per unit time/kJ m^{-2} yr^{-1};
c. bar width is proportional to the energy stored (in the biomass) in that trophic level;
d. the first/lowest trophic level is producers;
e. second level is primary consumers/herbivores;
f. third level of secondary consumers/carnivores;
g. only a small amount (10 to 20 %) of energy of one level is passed to the next;
h. bar width/energy stored in the trophic level decreases (proportionally) as you go up each level;
i. pyramid shows that there is a limit to the length of food chains;
Award any of the above marking points to a correctly drawn and clearly labelled pyramid.

18c. Explain the control of body temperature in humans. *[8 marks]*

Markscheme

a. normal body core temperature constant/36.5 to 37.5 °C; (*accept single values within this range*)
b. regulated by negative feedback/homeostatic mechanisms;
c. hypothalamus is the centre of thermoregulation;
d. hypothalamus sends impulses to the body to increase/decrease temperatures;
e. release of sweat (by sweat glands in the skin) if skin temperature rises;
f. evaporation of water cools the body; (*concept of evaporation must be mentioned*)
g. heat is transferred by blood;
h. transfer of heat from body core in blood to surface;
i. if temperature rises, increased flow of blood/heat to the skin/vasodilation of skin blood vessels/arterioles; (*do not accept veins, arteries or capillaries*)
j. if temperature drops, decreased flow of blood/heat to the skin/vasoconstriction of skin blood vessels/arterioles; (*do not accept veins, arteries or capillaries*)
k. shivering increases heat production (in muscles);
l. example of one behavioural mechanism; (*eg reducing activity (to lower body temperature) / reducing exposed surfaces (to reduce heat loss*)

19a. Describe **four** properties of water that are due to hydrogen bonding and polarity. *[4 marks]*

Markscheme

Descriptions of properties expected not lists of properties.

hydrogen bonding:
a. high specific heat capacity requiring large amounts of energy to break the H-bonds/to raise the temperature;
b. boiling point is high/100 °C as H-bonds must be broken to change from liquid to gas;
c. cooling effect of evaporation due to H-bonds taking energy from liquid water to break / high latent heat of evaporation;
d. water molecules on surface resistant to forces because of surface tension;
e. water is most dense at 4 °C due to more regular hydrogen bonding;

polarity:
f. water molecules stick together through cohesion; (*full idea required*)
g. water molecules stick to other polar molecules through adhesion; (*full idea required*)
h. good solvent of polar organic molecules

19b. Describe how water is carried through a flowering plant. *[6 marks]*

Markscheme

a. active transport of solutes from soil into roots;
b. draws water by osmosis
c. root hairs provide a large surface area for water uptake;
d. carried through xylem vessels;
e. transpiration is the loss of water (vapour) from leaves and stems / stomata;
f. (transpiration) creates suction/pull/negative pressure;
g. cellulose wall with rings of lignin give strength to resist (low) pressure;
h. water pulled up due to capillary action/cohesion/adhesion;
i. continuous column of molecules/transpiration stream;

19c. Some of the water carried to the leaves of a plant is used in photosynthesis. Explain the role of water in the light-dependent reactions of photosynthesis. *[8 marks]*

Markscheme

a. water only plays a role in non-cyclic photophosphorylation;
b. chlorophyll absorbs light/photons and activates electrons of photosystem II;
c. excited/active electrons of photosystem II are passed to carriers;
d. photolysis is the splitting of water;
e. produces O_2 and H^+/proton and electrons;
f. O_2 released (as waste);
g. electrons (from water) replace lost electrons in photosystem II;
h. electrons from photosystem II pass (through carriers) to photosystem I;
i. electrons from photosystem I pass to $NADP^+$ (in stroma);
j. $NADP^+$ accepts H^+/proton (from water) to form NADPH;
k. electron flow causes protons pumped across thylakoid membranes/into the thylakoid space;
l. creating a proton concentration gradient;
m. chemiosmosis couples electron transport to ATP synthesis;
n. protons pass through ATP synthase/synthetase;
o. NADPH/H^+/proton is passed to the light-independent reactions (to fix carbon);

20a. State the role of **four named** minerals needed by living organisms. *[4 marks]*

Markscheme

sulfur – part of amino acids / proteins;
calcium – strengthening/formation of bones / muscle contraction / synaptic transmission;
phosphorus – formation of nucleic acids / ATP / GTP / NADP / phospholipids;
iron – formation of hemoglobin / transport of oxygen;
sodium – nerve impulse / sodium-potassium pump / osmoregulation;
potassium – nerve transmission / sodium-potassium pump / osmoregulation;
magnesium – part of chlorophyll molecule;

20b. Explain the processes by which minerals are absorbed from the soil into the roots. *[8 marks]*

Markscheme

plants absorb minerals in ionic form/mineral ions;
nitrate / phosphate / potassium / other example of mineral;
minerals can be absorbed by (facilitated) diffusion;
(diffusion is) movement of ions from high to low concentration/down concentration gradient;
root hair cells provide a large surface area for absorption;
fungal hyphae help to absorb minerals/phosphate;
minerals absorbed by active transport;
as mineral ion concentration is smaller outside the root than inside / absorbed against a concentration gradient;
active transport requires energy/ATP;
occurs through pump/carrier proteins;
proton pump transports hydrogen ions/H^+ out of cell (allowing mineral movement in);

20c. In anaerobic conditions, plants release energy by glycolysis. Outline the process of glycolysis. *[6 marks]*

Markscheme

occurs in cytoplasm (of cell);
substrate is hexose/glucose/fructose;
phosphorylation of glucose/fructose/hexose;
to form hexose diphosphate/glucose 6-phosphate;
requires ATP;
glucose/fructose/hexose (diphosphate) converted into (two) pyruvates/three carbon compounds;
oxidation;
to produce (two) NADH + H^+/ (two) reduced NADs;
net gain of two ATP (per glucose);

21a. Describe how plants carry out gas exchange in the leaves. *[5 marks]*

Markscheme

gases/O_2 and CO_2 enter/exit the leaf through the stomata;
by diffusion / down the concentration gradient;
photosynthesis maintains concentration gradients/high O_2 and low CO_2 in the leaf;
guard cells open the stomata during the day / close the stomata at night;
gases/O_2/CO_2 move through air spaces in the spongy (mesophyll);
CO_2 dissolves in moisture in (mesophyll) cell walls;

21b. Outline the causes and consequences of the enhanced greenhouse effect. *[5 marks]*

Markscheme

burning of (fossil) fuels/coal/oil/gas releases carbon dioxide;
deforestation/loss of ecosystems reduces carbon dioxide uptake;
methane emitted from cattle/livestock/melting permafrost/waste dumps;
heating of the atmosphere/global warming/climate change;
melting of ice caps/glaciers/permafrost / sea level rise / floods / droughts / changes in ocean currents / more powerful hurricanes / extreme weather events / other abiotic consequence;
changes in species distributions/migration patterns / increased decomposition rates / increases in pest/pathogen species / loss of ice habitats / other biotic consequence;

21c. Explain the role of limiting factors in photosynthesis. *[8 marks]*

Markscheme

factor nearest its minimum/furthest from its optimum is limiting;
increasing a limiting factor with other factors constant increases the rate;
increasing a non-limiting factor with other factors constant has no effect on rate;
light intensity is limiting in dim/low intensity light / at night;
photosynthesis (directly) proportional to intensity up to plateau / graph to show this;
light intensity affects the light-dependent reactions/production of ATP/NADPH;
temperature limiting at low and high temperatures;
optimum temperature with lower rates above and below plateau / graph to show this;
low temperatures limit the rate of light-independent reactions/Calvin cycle;
RuBP carboxylase/rubisco does not fix carbon dioxide at high temperatures;
carbon dioxide concentration is limiting in bright light and warm temperatures;
photosynthesis is (directly) proportional to CO_2 concentration up to plateau / graph to show this;
low CO_2 concentration limits carbon fixation/reaction between CO_2 and RuBP;

22a. Outline pollination, fertilization and seed dispersal. *[4 marks]*

Markscheme

pollination is the transfer of pollen to the stigma/carpel/pistil of a flower;
pollen grains grow a pollen tube down the style to the ovule;
male and female gametes/nuclei join/fuse (in the ovule/ovary) during fertilization;
the ovary matures into a fruit;
dispersal of seeds depends on the fruit;
example of seed dispersal; (*e.g. pods split open to scatter seeds, e.g. animal eats fruit / ingests and egests seed*)

22b. Compare the processes of spermatogenesis and oogenesis. *[8 marks]*

Markscheme

	spermatogenesis	*oogenesis*
a.	both start with germ cells/germinal epithelium (of gonad);	
b.	both start with mitosis to produce many cells;	
c.	both involve cell growth before mitosis;	
d.	both involve meiosis/reduction division/create haploid cells;	
e.	occurs in testes	occurs in ovaries;
f.	millions/large numbers produced daily	one/few produced per month;
g.	released during ejaculation	released during ovulation/mid-way through cycle;
h.	begins during puberty	egg production begins before birth;
i.	continues throughout life	production stops at menopause;
j.	four sperm made per meiosis	only one egg produced per meiosis;
k.	polar bodies not produced/equal division	polar bodies produced/uneven division of cytoplasm;
l.	cytoplasm is reduced in sperm	cytoplasm is enhanced in eggs;
m.	sperm are motile	eggs are not motile;

*To award **[8 max]**, responses must provide at least one similarity. Responses do not need to be shown in a table format.*

23a. Outline how **three** properties of water enhance its use by living organisms. *[6 marks]*

Markscheme

cohesive properties help in transpiration pull/movement of water in plants;
high surface tension allows some animals to stride across its surface;
high latent heat of evaporation/large amounts of energy required for evaporation makes it a good coolant;
high specific heat capacity causes it to maintain environmental temperatures;
low density as ice forms insulation of lakes allowing life below;
transparency for photosynthesis;
transparency for vision in animals;
solvent properties make it the medium for metabolic reactions;
solvent properties allow transport of (soluble) molecules/food;

23b. Describe the role of ADH in osmoregulation. *[4 marks]*

Markscheme

osmoregulation is control of water balance in organisms/blood/tissues/ cytoplasm;
ADH regulates water levels/solute concentration of the blood;
produced/released when water in blood is too low;
it increases the permeability of the collecting ducts / increase in the reabsorption of water;
leads to more aquaporins (in collecting duct cell membranes);
lower volume/less urine is produced/urine more concentrated;

23c. Explain how water is moved from roots to leaves in terrestrial plants. *[8 marks]*

Markscheme

water enters roots through the root hairs by osmosis;
root hairs provide an extended surface area (for active transport and osmosis);
active transport of ions from soil into the roots (enhances osmotic pressure);
osmotic pressure moves water into the xylem;
water is carried (in a transpiration stream) in the xylem;
adhesion of water to the inside of the xylem helps move water up;
cohesion of water to itself enhances water movement up the xylem;
water diffuses into air spaces (in spongy mesophyll) of leaves;
it passes out through the stomata by evaporation/transpiration;
evaporation sets up a transpiration pull that keeps the water moving;
guard cells control the rate of transpiration pull/evaporation;
xylem vessels are tubes with helical rings to enhance water movement/resist low pressure;

24a. Outline the various stages of the cell cycle. *[4 marks]*

Markscheme

G_1 the cell grows/duplication of organelles;
S is synthesis stage when DNA is synthesized/replicated;
G_2 the chromosomes begin condensing/preparation for cell division;
G_1 , S and G_2 make up interphase;
during mitosis nuclear division occurs/all four stages listed;
during cytokinesis cytoplasm/cell divides/daughter cells formed;

24b. Define the term *transpiration* and explain the factors that can affect transpiration in a typical terrestrial plant. *[9 marks]*

Markscheme

(transpiration is) loss of water vapour from the leaves/stomata (and stems) of plants;
temperature, humidity, light (intensity) and wind <u>all affect</u> transpiration;
high temperatures increase evaporation rate of water/transpiration; *(accept converse)*
high humidity lowers the rate of water evaporation/transpiration; *(accept converse)*
air currents/wind increase water evaporation/transpiration; *(accept converse)*
high light (intensity)/sunlight (usually) increases photosynthesis/water evaporation through the stomata/transpiration;
stomata open to allow gaseous exchange/entry of CO_2;
abscisic acid stimulates closing of stomata;
guard cells open/close the stomata;
adaptations of (xerophyte) plant structures reduce water loss/transpiration;
one example;
(thicker leaf cuticle / reduced surface area/rolled leaves/spines / sunken/reduced stomata / close stomata in day / low growth form / CAM / C4 physiology)
second example; *(of above)*
*Award **[8 max]** if definition is missing.*

25. Photosynthesis and transpiration occur in leaves. Explain how temperature affects these processes. *[8 marks]*

Markscheme

photosynthesis rate increases as temperature rises (up to an optimum temperature);
(due to) increase in the rate of enzyme catalysed reactions/light independent reactions/the Calvin cycle;
(steep) drop in rate of photosynthesis above the optimum;
at high temperatures enzymes/Rubisco/RuBP carboxylase denature(s);
graph with correctly labelled axes showing relationship between temperature and rate of photosynthesis;
transpiration rate increases as temperature rises;
(energy/heat leads to more) to more evaporation of water (in the leaf);
faster diffusion of water vapour at higher temperatures;
relative humidity falls as temperature rises / warmer air can hold more water vapour;
stomata may close at very high temperatures reducing the transpiration rate;
some plants open their stomata at very high temperatures to cool by transpiration;

26a. Outline the structure of a ribosome. *[4 marks]*

Markscheme

small subunit and large subunit;
mRNA binding site on small subunit;
three tRNA binding sites / A, P and E tRNA binding sites;
protein and RNA composition (in both subunits);

26b. Distinguish between fibrous and globular proteins with reference to **one** example of each protein type. *[6 marks]*

Markscheme

fibrous proteins are strands/sheets whereas globular proteins are rounded;
fibrous proteins (usually) insoluble whereas globular proteins (usually) soluble;
globular more sensitive to changes in pH/temperature/salt than fibrous;
fibrous proteins have structural roles / other specific role of fibrous protein;
globular proteins used for catalysis/transport/other specific role of globular protein;
another role of globular protein;
named fibrous proteins *e.g.* keratin/fibrin/collagen/actin/myosin/silk protein;
named globular protein *e.g.* insulin/immunoglobulin/hemoglobin/named enzyme;
Do not accept statements about fibrous proteins having only secondary structure and globular proteins having only tertiary structure.

26c. Auxin is a protein. Explain its role in phototropism. *[8 marks]*

Markscheme

auxin is a plant hormone;
produced by the tip of the stem/shoot tip;
causes transport of hydrogen ions from cytoplasm to cell wall;
decrease in pH / H^+ pumping breaks bonds between cell wall fibres;
makes cell walls flexible/extensible/plastic/softens cell walls;
auxin makes cells enlarge/grow;
gene expression also altered by auxin to promote cell growth;
(positive) phototropism is growth towards light;
shoot tip senses direction of (brightest) light;
auxin moved to side of stem with least light/darker side

causes cells on dark side to elongate/cells on dark side grow faster;
Accept clearly annotated diagrams for phototropism marking points.

27a. Draw a labelled diagram of the structure of a chloroplast as seen with an electron microscope. *[4 marks]*

Markscheme

*Award **[1]** for each of the following clearly drawn and correctly labelled. Label lines must be unambiguous in terms of what they are indicating.*
double/inner and outer membrane/envelope – shown as two concentric continuous lines close together;
granum/grana – shown as a stack of several disc-shaped subunits;
(intergranal) lamella – shown continuous with thylakoid membrane;
thylakoid – one of the flattened sacs;
stroma;
(70S) ribosomes/(circular) DNA / lipid globules / starch granules / thylakoid space;

27b. Describe how water is carried by the transpiration stream. *[7 marks]*

Markscheme

transpiration is water loss (from plant) by evaporation;
flow of water through xylem from roots to leaves is the transpiration stream;
evaporation from spongy mesophyll cells;
replaced by osmosis from the xylem;
(diffusion of water vapour) through stomata;
water lost replaced from xylem / clear diagram showing movement of water from xylem through cell(s) (walls) to air space;
water pulled out of xylem creates suction/low pressure/tension; transpiration pull results;
water molecules stick together/are cohesive;
due to hydrogen bonding/polarity of water molecules;
xylem vessels are thin (hollow) tubes;
adhesion between water and xylem due to polarity of water molecules;
creates continuous column/transpiration stream;

27c. Explain how flowering is controlled in long-day and short-day plants. *[7 marks]*

Markscheme

flowering affected by light;
phytochrome;
exists in two (interconvertible) forms/P_{fr} and P_r;
P_r (red absorbing/660 nm) converted to P_{fr} (far-red/730 nm absorbing) in red or day light;
sunlight contains more red than far red light so P_{fr} predominates during the day;
gradual reversion of P_{fr} to P_r occurs in darkness;
P_{fr} is active form / P_r is inactive form;
in long-day plants, flowering induced by dark periods shorter than a critical length / occurs when day is longer than a critical length;
enough P_{fr} remains in long-day plants at end of short nights to stimulate flowering;
P_{fr} acts as promoter of flowering in long-day plants;
short-day plants induced to flower by dark periods longer than a critical length/days shorter than a critical value;
at end of long nights enough P_{fr} has been converted to P_r to allow flowering to occur;
P_{fr} acts as inhibitor of flowering in short-day plants;