3 Movement of substances in living organisms

Using and interpreting data

Question	Mark scheme	Marks
1 a)	*(10 to 30 minutes)* • (1) decrease (in CO_2) • (2) carbon dioxide used in photosynthesis *(30 to 40 minutes)* • (3) (steep) rise then levels off (almost back to CO_2 conc. in air) / eq • (4) carbon dioxide rapidly enters bag from air in room / eq	2 2
b)	• increase (in % humidity) • transpiration / evaporation • stomata open / eq • water passes out of leaf / into bag • collects in bag / eq	3
c) i)	1 both graphs labelled (A and B, or carbon dioxide and humidity) 2 both graphs start from same positions as on first graph 3 CO_2 graph rises steadily and does not fall (student may need to extend vertical axis to show the rise) 4 humidity graph rises steadily and does not fall	3
ii)	• no photosynthesis in dark / CO_2 not taken up in dark / eq • respiration continues and produces CO_2 (collects in bag) / eq	2
Total		**12**

Question	Mark scheme	Marks
2 a) i)	• *(left hand side)* carbon dioxide + water (= / arrow) • *(right hand side)* (= / arrow) glucose / carbohydrate + oxygen *(accept symbols for words even if equation is not balanced)*	2
ii)	• (colour of indicator) shows carbon dioxide concentration / eq • shows the concentration (of carbon dioxide) left in the tube after 60 minutes / eq • if carbon dioxide concentration is high (after 60 minutes), the rate of photosynthesis is low / vice versa / eq • one example of colour linked correctly to carbon dioxide concentration or pH (e.g. turns purple in low concentration of carbon dioxide / alkaline / high pH / eq)	3
b) i)	• rate of photosynthesis increases with increasing light intensity / eq • steep increase (in rate of photosynthesis) with increasing light at lower light intensities / eq • moderate increase (in rate of photosynthesis) at middle light intensities / eq • less increase (in rate of photosynthesis) at higher light intensities / levels off / eq • relevant figures from graphs quoted to support any of the above *(for 1 mark)* • rate of photosynthesis increases then falls off / eq *(if no reference to light intensity)*	3
ii)	• 'high chlorophyll' algal balls have higher rate of photosynthesis / *or* converse for 'low chlorophyll' / eq • 'high chlorophyll' algal balls, rate of photosynthesis increases more rapidly at low light intensities / converse / eq • relevant figures from graphs quoted to support any of the above • eq	2
Total		**10**

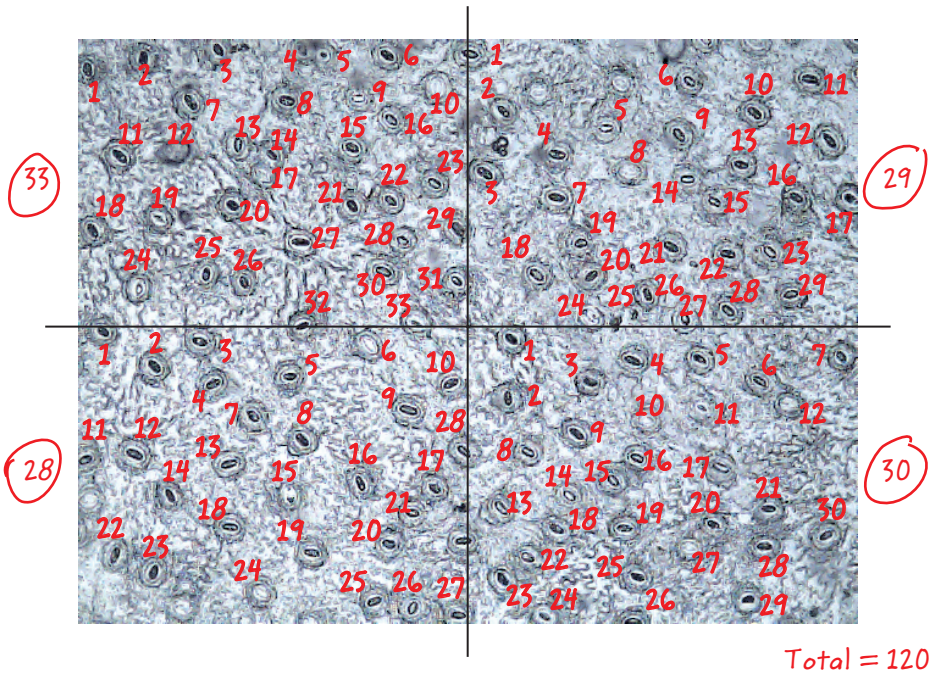
Question	Mark scheme	Marks
3 a) i)	• people concerned about effects on health • specific examples (e.g. link to cancer, heart disease) / eq • education (about effects of smoking) / publicity (e.g. campaigns, advertising) / government advice / eq • individuals cut down on number of cigarettes smoked (e.g. per day) / eq • costs / too expensive / effects of taxation / eq • eq	2
ii)	• world population increased (so overall increase in production even if individuals smoke fewer) / eq • USA (shown in graph 2) not typical of other countries / eq • more people take up smoking (in other countries) / eq • change in age pattern of smoking (e.g. more younger people smoke) / eq • eq	2
b)	• tar (in smoke) • damage to cilia / tiny hairs on surface of bronchi / bronchioles • less effective mechanism for moving mucus layer (out of lungs) / eq • mucus builds up in passages in lungs / 'airways' tend to get blocked / eq • bacteria / dust / eq not removed, more chance of infection / eq • eq	3
c)	• carbon monoxide combines with haemoglobin / oxyhaemoglobin • less haemoglobin available to transport oxygen • cells receive less oxygen • (oxygen) needed for respiration • person is breathless / lacks energy / eq	2
d)	• alveoli provide the gas exchange surface (between lungs and blood) / eq • (if less elastic) cannot expand / fill with air when air drawn into lungs / eq • reduces surface area (for gas exchange) / eq • less oxygen passes into blood • shorter breaths (as in breathlessness) allow higher ventilation rate / eq	2
Total		**11**

Practical activities

Question	Mark scheme	Marks
1 a) i)	(1) appropriate number of rows and columns, depending on orientation of table (2) suitable headings for rows / columns, including units (seconds / eq and % / percent / eq) (3) time correctly inserted, including 0 or 1 second for first reading (4) results for oxygen concentration correctly inserted (5) + (6) up to 2 marks for calculation of percentage difference *(all correct = 2, one error = 1, more errors = 0)*	5
ii)	• repeat the experiment several times and calculate the mean value / eq	1
iii)	• the longer the breath is held, the smaller the amount / percentage of oxygen in exhaled air / the greater the amount of oxygen absorbed / eq *OR* • the rate at which oxygen is absorbed decreases, as time breath is held increases / eq	1
b) i)	• alveoli / air sacs	1
ii)	• (while air is in the lungs) oxygen diffuses / eq • from alveoli / gas exchange surface, to blood / eq • from high concentration to low concentration / down concentration gradient / eq • the longer the breath is held, the more time there is for oxygen to diffuse into the blood / eq • progressively less diffuses as student holds breath for longer / eq • (because) smaller difference in concentration gradient between alveoli and blood / eq	4
Total		**12**

Question	Mark scheme	Marks
2 a) i)	• 2 columns + headings (number of stomata in section + section) • 4 rows + 1 for heading (+ can have one for totals) *(can accept variation in table – which are columns and which are rows – but it must include the necessary information)*	2
ii)	• lines drawn to show sections • counts for 2 sections (nearly) correct • counts for other 2 sections (nearly) correct *(see diagram for one set of results [33 + 29 + 28 + 30], though other people will get different 'results' depending on where they drew their grid and their system for counting, hence the 'nearly' correct)*	3
iii)	• system for checking / numbering stomata during counting / eq • decide how to count those on boundaries (e.g. larger proportion allocated to that section) • decide how to record those that are doubtful *(probably closed stomata)* • eq	2
b) i)	*mark is for adding up to give the total, then saying which is more, even if the wrong answer is given* *likely answer for green area* (total = 120) *see comment above about differences in doing the counts*	1
ii)	• sample more areas on same leaf area / do more peels (and do counts) • do peels from more leaves (and sample in similar way) • ref reliability / repeat counts • use counts done by different people to reduce individual error • eq	2
c)	• (no stomata) reduces loss of water / ref transpiration / helps conserve water / eq • if no stomata (on upper surface), reduces loss of water from part of leaf in direct sunlight • underside of leaf more humid / shaded / eq	2
Total		**12**

Note for part (a) (ii):
This is probably more counting than you would get in an examination question, but given here to give you practice in how to do this and the decisions you need to take to get suitable results in a similar practical situation. Check with the diagram to see how closely you agree.



Question	Mark scheme	Marks
3 a)	• set of 4 tubes, each with different-sized balls • replicate tubes (× 2 or × 3 tubes of each size ball) • (in each tube) same number of balls / same depth of balls in tube / same mass of balls / eq • same volume of (hydrogencarbonate) indicator (in each tube) • named other condition same (e.g. light / temperature) • eq	4
b)	• carbon dioxide produced • by respiration (in algae)	2
c) i)	• (yellow) to orange-red / to red / to purple • photosynthesis occurs (in light) • uses carbon dioxide • eq	3
ii)	• match colours in indicator / tubes against colours on colour chart / eq • choose colour to be 'end point' for observation • all tubes start from same colour (e.g. yellow) • measure time for tubes to reach (agreed) end point • repeat measurements (e.g. start to finish) / eq • measure / record the diameter of algal balls • eq	3
iii)	• smaller balls, indicator changes colour more quickly / show faster use of carbon dioxide / faster rate of photosynthesis / eq • ref larger surface area in relation to volume / carbon dioxide can escape more easily from inside of ball / eq *OR* • larger balls (show faster use of carbon dioxide / rate of photosynthesis / indicator changes colour more quickly / eq) • more chlorophyll in each ball / eq *(depends on how the student counted or controlled number of balls when setting up)* *(allow reasonable supporting reason in relation to the suggestion)*	2
Total		**14**

Question	Mark scheme	Marks
4 a) i)	• (using graph) eliminates variation / anomalies / dubious readings / gives better average over whole time / eq • (if only final) might be error in that reading • graph better as helps show pattern during the time (of investigation) • eq	2
ii)	• (total) distance ÷ time (in minutes) • same distance and time for each place • gradient of (both) graphs	2
iii)	• rate of transpiration is same as rate of water uptake (i.e. movement of meniscus along capillary tube) / eq	1
b) i)	• test / vary one factor at a time (e.g. effect of difference in humidity, difference in temperature) • keep all other factors the same (e.g. temperature, light, wind speed) • eq	2
ii)	• use same plant each time / use different plants (same species) but approx. same area of leaf on the shoot / eq • repeats / replicates of readings	2
iii)	• allow time for plant to settle in each new condition / eq	1
Total		**10**

Understanding structure, function and processes

Question	Mark scheme	Marks
1 a) i)	• shape (circular + biconcave) • (label) cell membrane / cytoplasm *(if nucleus shown, 2nd mark = 0)*	2
ii)	• (white blood cells) various shapes / irregular shape / not biconcave / eq • (white blood cells) nucleus present • (white blood cells) larger size / eq	2
b) i)	• contain haemoglobin / eq • (haemoglobin) combines with oxygen / eq • no nucleus so more space for haemoglobin • biconcave shape so large surface area to volume ratio • (large SA to volume ratio) allows rapid diffusion of oxygen / gaseous exchange / eq • small size / biconcave shape allows them to squeeze through small capillaries / eq	3
ii)	• pulmonary vein	1
c)	• pathogens ingested / engulfed / eq, by phagocytes • pathogens broken down by enzymes / digested / destroyed / eq *OR* • antibodies made / released by lymphocytes • antibodies, attach to pathogen / destroy pathogen / eq OR specific to antigen / eq *(both points should relate to same type of white blood cell)*	2
Total		**10**

Question	Mark scheme	Marks
2 a) i)	• B / trachea	1
ii)	• keep trachea open / avoid being closed by food passing down oesophagus / eq	1
b) i)	• F / ribs • H / diaphragm	2
ii)	• (ribs) intercostal / muscles between ribs (contract) • move ribcage / ribs up and out • (diaphragm) pulled flat / not domed shape / eq • increases volume of chest cavity / eq • pressure lowered + air drawn in / eq	4
c) i)	• E	1
ii)	• large surface area / eq • thin (surface) • moist (surface) • close contact with many blood capillaries / eq	2
Total		**11**

Question	Mark scheme	Marks
3 a) i)	• root hair cells	1
ii)	• osmosis	1
iii)	• long extension / eq • provides large surface area / eq • thin walls • eq	2
b) i)	• 'tubes' with narrow diameter / eq • no end walls • continuous column water / no barriers / eq • (column / water molecules) held together by cohesion • (narrow tubes) capillarity • eq	2
ii)	• lignified walls / eq	1
c) i)	• transpiration / evaporation / eq	1
ii)	• stomata / stoma	1
iii)	• guard cells (surround stoma / pore / gap) • take in more water / become turgid *OR* lose water / become flaccid • ref curved shape / eq allowing more gap / *OR* flaccid + closes pore / gap • ref sunlight (open) / eq *OR* dark (closed) • eq	3
Total		**12**

Question	Mark scheme	Marks
4 a) i)	• transpiration / evaporation	1
ii)	• transpiration pull / description, contributes to water uptake / eq • transpiration rate / rate of evaporation faster on dry day (compared to humid day) / accept reverse / eq • transpiration rate / rate of evaporation faster on windy day (compared to still day) / accept reverse / eq • therefore more water uptake when rate of transpiration / eq faster	4
b)	• (thick) waxy cuticle (reduces water loss through surface) • lack of stomata on outside surface • rolled leaf retains humid / moist air in region inside the curve / eq • stomata present inside but reduced transpiration / evaporation into humid / eq region • hairs trap moisture inside the curve / eq	4
Total		**9**

Question	Mark scheme	Marks
5 a)	• lungs	1
b) i)	• left ventricle	1
ii)	• C has thicker walls than B / eq • (C) pumps blood all round body / (B) pumps only to lungs • needs high pressure / more muscle to contract / eq	2
c) i)	• B	1
ii)	• most veins carry blood back to heart from cells / tissues / eq • (cells) use oxygen in respiration / eq • vessel E different as back to heart from lungs / collected oxygen / eq	2
d)	• carries absorbed / digested food • from small intestine to liver • sugars from breakdown of carbohydrate / amino acids from breakdown of proteins / eq	2
e) i)	• D	1
ii)	• (high pressure) needed to maintain circulation all round body / eq • eq	1
f)	• F = renal artery (higher urea), G = renal vein (lower urea) / blood vessels to and from kidney / eq • kidney function removes urea / eq • ref ultrafiltration / eq • selective reabsorption of other materials / eq • urea passes out in urine / eq	2
g) i)	• (*any vein*) e.g. B, G, H, K	1
ii)	• prevent blood flowing backwards / eq	1
Total		**15**

Applying principles

Question	Mark scheme	Marks
1 a) i)	• plasma	1
ii)	• enzymes are specific for substrate / work only with correct / one substrate / eq • active site on enzyme, glucose 'fits' / eq	2
b)	• respiration, uses / decreases (glucose) • any vein out of tissue (e.g. from muscle / any cells) *OR* • storage of glucose in liver as glycogen, decreases / removes (glucose) • hepatic vein / change from level in hepatic artery *OR* • release of glucose from stored glycogen in liver / muscles, increases / releases (glucose) • hepatic vein / change from level in hepatic artery *OR* • absorption of glucose from digested food (after a meal), increase • hepatic portal vein *OR* *eq + eq* *(process + increase or decrease = 1 mark)* *(linked to correct blood vessel = 1 mark)*	4
c) i)	• pancreas	1
ii)	• stimulates uptake of glucose by liver / muscles • converted to glycogen (and stored)	2
d)	• fungal culture grown in fermenter / eq • (culture) provided with oxygen / nutrients / correct temperature / aseptic conditions / stirring / eq • enzymes collected from growth medium / eq	2
Total		**12**

Question	Mark scheme	Marks
2 a) i)	• (rise caused by carbon dioxide from) respiration • of students / people in the room • in exhaled air • no exchange of air / 'fresh air' from outside room • eq	3
ii)	• (fall caused by) green plants use / take in carbon dioxide • for photosynthesis • in light • not enough carbon dioxide given off from respiration / eq	3
iii)	• carbon dioxide level rises • plant no longer carries out photosynthesis / takes in carbon dioxide • carbon dioxide from respiration causes rise in level / eq	2
b) i)	• vertical axis labelled carbon dioxide concentration (but no units expected) • horizontal axis labelled time in hours, show full range of 24 hours (can be in blocks) • curve to show fluctuation in relation to time of day / possible light and dark changes / sensible relationship showing high carbon dioxide at night, lower during day *(detailed answers in ii) but here mark for sensible fluctuations in curve)*	3
ii)	*(reasons – actual interpretations could be different as maize field could be in any time zone / latitude / time of year etc. but assume descriptions given as reasonable 'norm')* • (midnight to 06.00 hrs) carbon dioxide high, respiration but no photosynthesis, light too low • (06.00 to 12 noon) carbon dioxide high then begins to fall as light intensity increases because carbon dioxide taken up (by maize plants and used for photosynthesis) • (12 noon to 18.00 hrs) carbon dioxide low as light intensity continues to be high and photosynthesis continues to use carbon dioxide • (18.00 hrs to midnight) carbon dioxide begins to rise as light becomes too low for photosynthesis and carbon dioxide continues to be produced from respiration • eq	4
Total		**15**

Question	Mark scheme	Marks
3 a) i)	• alveoli / alveolus / air sacs	1
ii)	• lower concentration of oxygen (in alveoli) • less difference in the concentration gradient (between alveoli and blood in capillaries) / eq • slower rate of diffusion (of oxygen into blood)	2
iii)	• increased ventilation (into lungs) / brings more fresh air into lungs / eq • increases available oxygen (to diffuse into blood) / eq • eq	2
b) i)	• haemoglobin carries oxygen to cells / oxyhaemoglobin / eq • more haemoglobin so more oxygen available to release energy / eq • by respiration • helps to overcome shortage of oxygen in the air (at high altitude) / eq	2
ii)	• shows relevance of their study in wider science context / supports their own findings / eq	1
c)	• more haemoglobin remains in the body, carries more oxygen to cells / eq • more energy released by respiration so higher performance / eq	2
Total		**10**