

# Markscheme

**May 2019**

**Biology**

**Standard level**

**Paper 3**

20 pages

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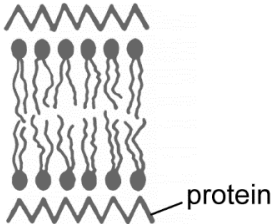
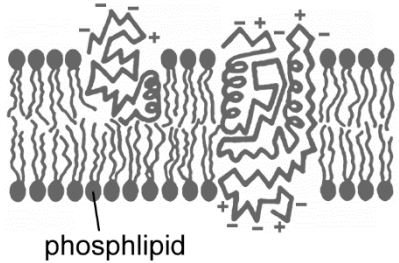
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**Section A**

Question			Answers	Notes	Total
1.	a		Davson–Danielli ✓		1
1.	b	i	 <p style="text-align: right;">✓</p> <p>[Source: diagram from article published in <i>The American Journal of Pathology</i>, <b>65</b>, J Singer and G Nicolson, The structure and chemistry of mammalian cell membranes, 427–437, Copyright Elsevier (1971)]</p>	<i>Accept label to top protein.</i>	1
1.	b	ii	 <p style="text-align: right;">✓</p> <p>[Source: diagram from article published in <i>The American Journal of Pathology</i>, <b>65</b>, J Singer and G Nicolson, The structure and chemistry of mammalian cell membranes, 427–437, Copyright Elsevier (1971)]</p>	<i>Accept a label to any part of any phospholipid Accept different form of labelling that clearly indicate the phospholipids.</i>	1
1.	c	i	<p>a. phospholipids on outside/exposed ✓</p> <p>b. impossibility of continuous protein layer «of Davson–Danielli/model A» ✓</p> <p>c. supports idea of mosaic pattern of membrane <b>OR</b> supports model B ✓</p>	<i>Award any other valid conclusion. Do not accept "membrane is made of phospholipids".</i>	1 max

(continued...)

(Question 1 continued)

Question			Answers	Notes	Total
1.	c	ii	a. pH values away from optimum pH affect enzyme <b>OR</b> so enzyme can function properly <b>OR</b> pH 7.5 is the optimum pH for the enzyme ✓ b. sketch of enzyme activity versus pH ✓ c. change in pH affects 3D structure of protein/active site <b>OR</b> change in pH denatures the enzyme / protein ✓ d. substrate does not fit in active site <b>OR</b> interaction of substrate and active site affected ✓	Sketch of enzyme activity needs labels.	2 max
1.	d		a. scanning electronmicrography / SEM ✓ b. freeze fracture/etching ✓ c. X-ray diffraction <b>OR</b> crystallography ✓ d. fluorescent antibody / marker tagging ✓	Do not accept electron microscope  Accept description of process	1 max
2.	a		0.45 «mm» ✓	Allow values between 0.35 «mm» and 0.50 «mm»	1
2.	b		a. thymine / T ✓ b. because only in DNA / not in RNA ✓		2

Question		Answers	Notes	Total
3.	a	age/height/fitness level/weight/room temperature/rest in between tests/model or type of bike ✓	<i>Other valid factor. Only mark first factor listed.</i>  <i>Do not accept sex, health, smoking, oxygen level or altitude as this already listed.</i>	1
3.	b	a. in both sea level and 4000 m ventilation rate while exercising «at all intensities» is «significantly» more than at rest <b>OR</b> both sea level and 4000 m show an increase in ventilation rate «dm <sup>3</sup> min <sup>-1</sup> » as exercise intensity increased ✓  b. ventilation rate at 4000 m «slightly» higher than at sea level for all conditions <b>OR</b> higher ventilation rate at 4000 m not «significantly» different as error bars overlap ✓	<i>Accept positive correlation.</i>	2 max
3.	c	a. «data logging» with spirometer <b>OR</b> chest belt ✓  b. «tidal» volume recorded for a given period of time <b>OR</b> average «tidal» volume found and multiplied by number breaths per minute ✓	<i>Do not accept confusion with respirometer (measuring oxygen consumption or CO<sub>2</sub> release).</i>  <i>Must include a reference to time.</i>	2

**Section B**

**Option A — Neurobiology and behaviour**

Question		Answers	Notes	Total
4.	a	a. poor performers performed «much» better after a diet with cinnamon ✓ b. cinnamon made good performers perform slightly better/the same ✓		2 max
4.	b	a. developing neurons form multiple synapses, so there are more connections between neurons ✓ b. synapses that are not used do not persist/neural pruning ✓ c. less synapses means there is less interference of stimuli / less background noise ✓ d. neurons/synapses that are used a lot are reinforced so information is accessed faster in neurons ✓		3 max
4.	c	a. reorganization of brain function through plasticity «which is enhanced by cinnamon» ✓ b. cinnamon helps to form new neural pathways to replace the ones that were lost «due to the stroke» ✓		1 max

Question		Answers	Notes	Total
5.	a	the longer ago they diverged from humans, the greater the relative brain mass ✓	<i>Accept inverse.</i>  <i>Do not accept negative correlation.</i>	1
5.	b	a. human cerebral cortex has extensive folding producing a greater mass ✓ b. better diet/more protein allowed increase in «relative» brain mass in humans ✓ c. others had larger body to protect them from predators «without increase in brain mass» ✓		1 max
5.	c	a. not a good indicator because it depends on body mass ✓ b. not a good indicator as less developed organisms show a larger relative brain mass ✓	<i>Accept answers referring to specific organisms shown</i>	1 max
5.	d	a. neurons formed by a process called neurulation ✓ b. neurons are «initially» produced by differentiation «in the neural tube» ✓ c. immature neurons migrate to a final location ✓ d. an axon grows from each immature neuron in response to chemical stimuli ✓ e. some axons extend beyond the neural tube to reach other parts of the body ✓ f. a developing neuron forms multiple synapses ✓		2 max

Question		Answers	Notes	Total
6.	a	X: semicircular canals ✓ Y: eardrum/tympanic membrane ✓		2
6.	b	a. sound picked up by microphone relayed electronically to speech processor ✓ b. speech processor filters background noise/selects only speech frequencies ✓ c. «radio» signal from transmitter to receiver/stimulator which converts it to electric signal ✓ d. «electrical impulses» sent to electrode «array» in cochlea <b>OR</b> cochlear implant bypasses the hair cells in the cochlea ✓ e. electrode/electrical signal stimulates auditory nerve «fibers in cochlea» ✓ f. signals «generated by implant» sent to brain «which recognizes signals as sound» ✓	OWTTE	3 max



Question	Answers	Notes	Total
7.	<p>a. iris sphincter muscle / circular muscle / pupil constriction is controlled by the parasympathetic system ✓</p> <p>b. iris dilator / radial muscle / pupil dilation is controlled by the sympathetic system ✓</p> <p>c. at low light intensity pupil dilates  <b>OR</b>                      at high intensity it constricts  <b>OR</b>                      a reflex that controls the diameter of the pupil in response to intensity of light entering the eye ✓</p> <p>d. «under normal conditions» pupils of both eyes respond identically to a light stimulus                      «regardless of which eye is being stimulated» ✓</p> <p>e. response in one pupil without the other pupil responding is sign of a problem ✓</p> <p>f. delayed response may indicate damage to brain / optic nerve / problems in oculomotor nerve/brain stem / use of depressant drugs / brain death ✓</p>	<p><i>Accept no response</i></p>	<p><b>4 max</b></p>

**Option B — Biotechnology and bioinformatics**

Question		Answers	Notes	Total
8.	a	a. in batch culture the product is obtained just once <b>OR</b> the end products of digestion are required ✓  b. in the continuous fermenter biogas/methane is harvested constantly <b>OR</b> continuous fermentation is more productive, so ideal for production of methane ✓		2
8.	b	a. first days the production is low as bacteria are few ✓ b. biogas production increases as time passes «from day 2 to day 12» as bacteria reproduce and increase «exponentially» ✓ c. biogas production levels off «between days 14 and 20» because bacterial population has reached optimum level ✓ d. biogas production decreases «from day 22 to day 30» because clogging/contamination / biofilm formation occurs <b>OR</b> no more reactants are added «between days 14 and 20» ✓		3 max
8.	c	a. manure contains bacteria that digest cellulose to sugars ✓ b. more substrate/sugars to produce methane ✓		1 max

Question			Answers	Notes	Total
9.	a		a. open reading frame finder «ORF finder» detects sections of a DNA molecule likely to be genes <b>OR</b> search for significant length of DNA coding from a start codon to a stop codon ✓  b. BLASTn used to compare gene sequences coding for similar proteins in other organisms/databases ✓  c. BLASTp used to detect similar proteins in other organisms/databases ✓	Accept methionine/AUG as start codon and UAA/UAG/UGA as stop codon.  Accept any other verified software program.	2 max
9.	b	i	plasmid / Ti ✓		1
9.	b	ii	a. antibiotic resistance ✓  b. presence of a marker gene ✓  c. B galactosidase ✓	Accept green fluorescent protein/GFP or other example of a marker gene.	1 max
9.	b	iii	a. infection by <i>Agrobacterium tumefaciens</i>  b. modification by calcium chloride / liposomes / electroporation / microinjection / gunshot / biolistics ✓		1
9.	c		a. tobacco mosaic virus/TMV modified to carry gene of hepatitis B «surface antigen/HBsAg» ✓  b. «tobacco mosaic» virus infects tobacco plants <b>OR</b> its genetic material is incorporated into plant cells ✓  c. tobacco plants produce hepatitis B antigen ✓  d. «antigen» induces formation of antibodies/immune response «in humans» ✓		2 max

Question		Answers	Notes	Total
10.	a	a. cells/bacteria in a biofilm are close together ✓ b. cells secrete signaling molecules ✓ c. «signaling molecules» bind to receptors of other cells <b>OR</b> «signaling molecules» allow communication between cells ✓ d. a threshold is reached which enables emergent properties ✓		2 max
10.	b	a. polysaccharide matrix/EPS does not let antibiotic pass/limits transport of antibiotic ✓ b. reduced metabolic activity/growth rate of bacteria in biofilm contributes to resistance ✓ c. increased cell density limits transport of antibiotic «to the interior of biofilm» ✓ d. «horizontal» transfer of antibiotic resistance via plasmids ✓	OWTTE	1 max



**Option C — Ecology and conservation**

Question		Answers	Notes	Total
12.	a	a. <u>transect</u> across area to be studied ✓ b. count/record barnacles «per species» in <u>quadrats</u> at regular intervals ✓		2
12.	b	a. both species present throughout the range ✓ b. <i>C. montagui</i> has small number of individuals «throughout» <b>OR</b> <i>C. montagui</i> occupies «mostly» upper shore/intertidal zone c. <i>S. balanoides</i> «mostly» occupies low tide area ✓ <b>OR</b> <i>S. balanoides</i> has large number of individuals «throughout» ✓	<i>OWTTE referring to maximum numbers at specific heights.</i>	2 max
12.	c	a. native species/ <i>C. montagui</i> and <i>S. balanoides</i> have niches that don't overlap much / are distinct <b>OR</b> range of <i>E. modestus</i> overlaps with both native species ✓ b. niches of native species «which don't overlap much» shows competition between native species <b>OR</b> <i>E. modestus</i> invades habitats of <i>C. montagui</i> / <i>S. balanoides</i> resulting in competition with «both» native species ✓ c. EM has a wide niche/higher tolerance/covers entire «intertidal» range making it easier to invade the habitat ✓		2 max
12.	d	a. exposure/tides/waves ✓ b. temperature ✓ c. surfaces «of attachment» ✓ d. resource availability/nutrients ✓ e. pH ✓ f. light ✓ g. salinity ✓	<i>Do not accept biotic factors eg: "competition or predation"</i>	1 max

(continued...)

(Question 12 continued)

Question		Answers	Notes	Total
12.	e	a. indicator species need particular environmental conditions <b>OR</b> indicator species tolerate only certain environmental conditions ✓ b. increase/decrease in population size «over time» shows effect of environmental conditions ✓ c. used to calculate biotic index/index of cleanliness ✓ d. index of 10/high index number indicates totally unpolluted <b>OR</b> index of 2 or 1/low index number indicates severe pollution ✓		2 max
13.		a. seaweed close to the estuary/town has a higher concentration of copper ✓ b. birds feed on fish/seaweed that have accumulated copper ✓ c. copper accumulates in tissues of organisms/bioaccumulation ✓ d. copper accumulates at a rate faster than that at which it is lost by excretion ✓ e. copper concentration increases as trophic level increases ✓ f. biomagnification occurs ✓		3 max

Question		Answers	Notes	Total
14.	a	<ul style="list-style-type: none"> <li>a. light «penetration» ✓</li> <li>b. temperature ✓</li> <li>c. wind ✓</li> <li>d. fires ✓</li> </ul>	<p><i>Allow any two but mark only the first two if more are given in a list.</i></p>	<b>2 max</b>
14.	b	<ul style="list-style-type: none"> <li>a. reduction in diversity in fragmented forest as a whole ✓</li> <li>b. greater diversity towards the edge ✓</li> <li>c. new species appear/immigration of new/alien/invasive species ✓</li> <li>d. local species decrease/emigrate <b>OR</b> unable to move between fragments ✓</li> <li>e. faster species turnover than core forest ✓</li> </ul>		<b>2 max</b>
15.		<ul style="list-style-type: none"> <li>a. «food conversion ratio is» mass of animal food required to produce a certain product «in livestock» ✓</li> <li>b. product may be consumable meat / milk / eggs ✓</li> <li>c. some dietary choices are more sustainable than others <b>OR</b> maximum production of human food for little animal feed is desired ✓</li> <li>d. some animals are more efficient at converting feed into useful product than others. ✓</li> <li>e. amount of biomass lost affects this ratio ✓</li> <li>f. some animal feeds will be better for producing useable products than others ✓</li> </ul>	<p><i>Accept examples for any of these marking points.</i></p>	<b>4 max</b>



Option D — Human physiology

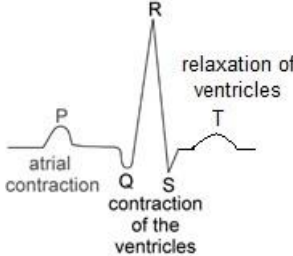
Question		Answers	Notes	Total
16.	a	positive relationship <b>OR</b> increases with age ✓		1
16.	b	a. higher BMI is associated with diabetes b. 50th percentile for diabetes are overweight «at all ages» <b>OR</b> 50th percentile is a higher BMI for diabetics «at all ages» <b>OR</b> 50th percentile for diabetes is close to the 75th percentile BMI of the entire population <b>OR</b> 50th percentile for diabetes is higher than 50% percentile for non-diabetic men ✓ c. chances of diabetes increase with age ✓ d. the graph does not show the information for each individual «just the percentiles» ✓		2 max

Question		Answers	Notes	Total
17.	a	hepatic artery ✓		1
17.	b	a. both produce pyruvate «from lactate» <b>OR</b> both produce CO <sub>2</sub> and H <sub>2</sub> O «via acetyl CoA» ✓ b. hepatocytes produce glucose from lactate but mitochondria-rich cells cannot ✓	<i>OWTTE – eg: “only hepatocytes produce glucose” would be acceptable.</i>	2
17.	c	a. detoxification ✓ b. production/secretion of bile ✓ c. conversion of cholesterol to bile salts ✓ d. production of plasma proteins ✓ e. nutrient storage ✓ f. glucose regulation «in blood» ✓ g. other function «eg deamination/transamination, conversion of ammonia to urea» ✓	<i>Only <b>two</b> functions are required.                      If more than two functions are given, mark only the <b>first two</b> listed.</i>	2

Question		Answers	Notes	Total
18.	a	a. cardiac muscle cells are branched ✓ b. rich in mitochondria ✓ c. rich in glycogen granules ✓ d. formed by short cylindrical cells ✓ e. contains <u>intercalated</u> discs ✓ f. has gap junctions ✓ g. «intercalated discs are» transverse cross-bands which represent the attachment site between adjacent cells ✓	<i>Do not accept myogenic as it is not a structure.</i>	2 max
18.	b	semilunar / sigmoid / pulmonary <u>and</u> aortic valve ✓		1
18.	c	a. action potential of atrium precedes the ventricle <b>OR</b> the phases happen later in ventricle <b>OR</b> atrium contracts before the ventricle ✓ b. atrium has a shorter phase 2/longer phase 2 in ventricle <b>OR</b> atrium falls abruptly in phase 2/ventricle shows a plateau in phase 2 ✓ c. phase 3 is more distinct/falls more abruptly in ventricular action potential ✓ d. ventricular phase is overall longer than atrial phase ✓		2 max

(continued...)

(Question 18 continued)

Question		Answers	Notes	Total
18.	d	<ul style="list-style-type: none"> <li>a. sketch with the correct shape ✓</li> <li>b. P, Q, R, S and T indicated ✓</li> <li>c. atrial contraction/systole/depolarisation labelled ✓</li> <li>d. ventricular contraction/systole/depolarisation labelled ✓</li> <li>e. ventricular relaxation/diastole/repolarization labelled ✓</li> </ul>	<p>Correct shape should show peaks at P R and T and dips at Q and S</p> 	<b>3 max</b>
19.		<ul style="list-style-type: none"> <li>a. nervous and hormonal control ✓</li> <li>b. impulses from sight/smell of food stimulates brain to send nerve impulses ✓</li> <li>c. impulses cause cells in stomach lining/ parietal cells to secrete acid/gastric juice ✓</li> <li>d. food entering the stomach stimulates the chemoreceptors/stretch receptors ✓</li> <li>e. chemoreceptors/stretch receptors send impulses to the brain ✓</li> <li>f. vagus nerve/brain sends a nervous impulse to endocrine cells in wall of stomach ✓</li> <li>g. endocrine cells release gastrin into the blood ✓</li> <li>h. gastrin induces the release of gastric juice to digest proteins ✓</li> <li>i. secretin/somatostatin decrease gastrin secretion ✓</li> </ul>		<b>4 max</b>