Markscheme

May 2019

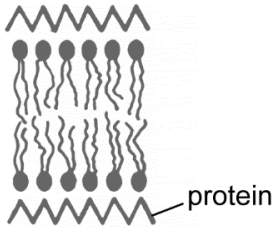
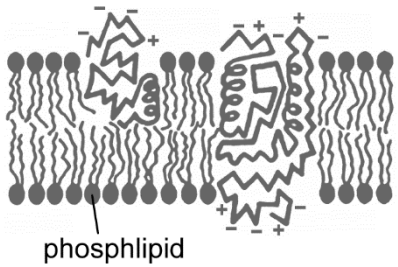
Biology

Standard level

Paper 3

20 pages

Section A

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

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**c**	**ii**	a. pH values away from optimum pH affect enzyme ***OR*** so enzyme can function properly ***OR*** 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 ***OR*** change in pH denatures the enzyme / protein ✓ d. substrate does not fit in active site ***OR*** 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 ***OR*** 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 ✓	*Other valid factor. Only mark first factor listed.* *Do not accept sex, health, smoking, oxygen level or altitude as this already listed.*	**1**
3.	**b**		a. in both sea level and 4000 m ventilation rate while exercising **«**at all intensities**»** is **«**significantly**»** more than at rest ***OR*** both sea level and 4000 m show an increase in ventilation rate **«**dm^3 min^{-1}**»** as exercise intensity increased ✓ b. ventilation rate at 4000 m **«**slightly**»** higher than at sea level for all conditions ***OR*** higher ventilation rate at 4000 m not **«**significantly**»** different as error bars overlap ✓	*Accept positive correlation.*	**2 max**
3.	**c**		a. **«**data logging**»** with spirometer ***OR*** chest belt ✓ b. **«**tidal**»** volume recorded for a given period of time ***OR*** average **«**tidal**»** volume found and multiplied by number breaths per minute ✓	*Do not accept confusion with respirometer (measuring oxygen consumption or CO_2 release).* *Must include a reference to time.*	**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 ✓	*Accept inverse.* *Do not accept negative correlation.*	**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 ✓	*Accept answers referring to specific organisms shown*	**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 ***OR*** 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.			a. iris sphincter muscle / circular muscle / pupil constriction is controlled by the parasympathetic system ✓ b. iris dilator / radial muscle / pupil dilation is controlled by the sympathetic system ✓ c. at low light intensity pupil dilates ***OR*** at high intensity it constricts ***OR*** a reflex that controls the diameter of the pupil in response to intensity of light entering the eye ✓ d. **«**under normal conditions**»** pupils of both eyes respond identically to a light stimulus **«**regardless of which eye is being stimulated**»** ✓ e. response in one pupil without the other pupil responding is sign of a problem ✓ f. delayed response may indicate damage to brain / optic nerve / problems in oculomotor nerve/brain stem **/** use of depressant drugs **/** brain death ✓	*Accept no response*	**4 max**

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
8.	**a**		a. in batch culture the product is obtained just once ***OR*** the end products of digestion are required ✓ b. in the continuous fermenter biogas/methane is harvested constantly ***OR*** 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 ***OR*** 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 ***OR*** 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 *Agrobacterium tumefaciens* 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 ***OR*** 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 ***OR*** **«**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**

Question			Answers	Notes	Total
11.			a. bacteria metabolize pollutants ***OR*** bacteria used in bioremediation ***OR*** microorganisms use pollutant as an energy source/carbon source ✓ *first named bacteria*: b. name of bacterium used in bioremediation **«***eg: Pseudomonas***»** ✓ c. name of pollutant/substrate **«***eg:* oil/methyl mercury**»** ✓ d. product of degradation **«***eg:* CO_2 and H_2O/elemental mercury**»** ✓ *second named bacteria*: e. name of bacterium used in bioremediation **«***eg: Marinobacter***»** ✓ f. name of pollutant/substrate **«***eg:* benzene**»** ✓ g. product of degradation **«***eg:* CO_2**»** ✓	*Award **[3 max]** if two bacteria are not named* *Allow any other verified example.* *Allow any other verified example.*	**4 max**

Option C — Ecology and conservation

Question			Answers	Notes	Total
12.	**a**		a. transect across area to be studied ✓ b. count/record barnacles **«**per species**»** in quadrats at regular intervals ✓		**2**
12.	**b**		a. both species present throughout the range ✓ b. *C. montagui* has small number of individuals «throughout» ***OR*** *C. montagui* occupies «mostly» upper shore/intertidal zone c. *S. balanoides* **«**mostly**»** occupies low tide area ✓ ***OR*** *S. balanoides* has large number of individuals «throughout» ✓	*OWTTE referring to maximum numbers at specific heights.*	**2 max**
12.	**c**		a. native species/*C. montagui* and *S. balanoides* have niches that don't overlap much / are distinct ***OR*** range of *E. modestus* overlaps with both native species ✓ b. niches of native species **«**which don't overlap much**»** shows competition between native species ***OR*** E. modestus invades habitats of C. montagui/S. balanoides 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 ✓	*Do not accept biotic factors* *eg: "competition or predation"*	**1 max**

(continued…)

(Question 12 continued)

Question			Answers	Notes	Total
12.	**e**		a. indicator species need particular environmental conditions ***OR*** 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 ***OR*** 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**		a. light «penetration» ✓ b. temperature ✓ c. wind ✓ d. fires ✓	*Allow any two but mark only the first two if more are given in a list.*	**2 max**
14.	**b**		a. reduction in diversity in fragmented forest as a whole ✓ b. greater diversity towards the edge ✓ c. new species appear/immigration of new/alien/invasive species ✓ d. local species decrease/emigrate ***OR*** unable to move between fragments ✓ e. faster species turnover than core forest ✓		**2 max**

15.			a. «food conversion ratio is» mass of animal food required to produce a certain product «in livestock» ✓ b. product may be consumable meat / milk / eggs ✓ c. some dietary choices are more sustainable than others ***OR*** maximum production of human food for little animal feed is desired ✓ d. some animals are more efficient at converting feed into useful product than others. ✓ e. amount of biomass lost affects this ratio ✓ f. some animal feeds will be better for producing useable products than others ✓	*Accept examples for any of these marking points.*	**4 max**

Option D — Human physiology

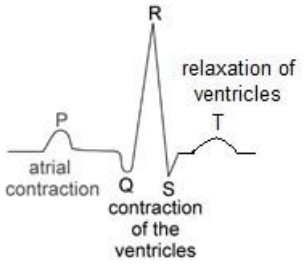
Question			Answers	Notes	Total
16.	**a**		positive relationship ***OR*** increases with age ✓		**1**
16.	**b**		a. higher BMI is associated with diabetes b. 50th percentile for diabetes are overweight **«**at all ages**»** ***OR*** 50th percentile is a higher BMI for diabetics **«**at all ages**»** ***OR*** 50th percentile for diabetes is close to the 75th percentile BMI of the entire population ***OR*** 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**»** ***OR*** both produce CO_2 and H_2O **«**via acetyl CoA**»** ✓ b. hepatocytes produce glucose from lactate but mitochondria-rich cells cannot ✓	*OWTTE – eg: "only hepatocytes produce glucose" would be acceptable.*	**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**»** ✓	*Only **two** functions are required.* *If more than two functions are given, mark only the **first two** listed.*	**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 ✓	*Do not accept myogenic as it is not a structure.*	**2 max**
18.	**b**		semilunar / sigmoid / pulmonary <u>and</u> aortic valve ✓		**1**
18.	**c**		a. action potential of atrium precedes the ventricle ***OR*** the phases happen later in ventricle ***OR*** atrium contracts before the ventricle ✓ b. atrium has a shorter phase 2/longer phase 2 in ventricle ***OR*** 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**		a. sketch with the correct shape ✓ b. P, Q, R, S and T indicated ✓ c. atrial contraction/systole/depolarisation labelled ✓ d. ventricular contraction/systole/depolarisation labelled ✓ e. ventricular relaxation/diastole/repolarization labelled ✓	*Correct shape should show peaks at P R and T and dips at Q and S*  	**3 max**

19.			a. nervous and hormonal control ✓ b. impulses from sight/smell of food stimulates brain to send nerve impulses ✓ c. impulses cause cells in stomach lining/ parietal cells to secrete acid/gastric juice ✓ d. food entering the stomach stimulates the chemoreceptors/stretch receptors ✓ e. chemoreceptors/stretch receptors send impulses to the brain ✓ f. vagus nerve/brain sends a nervous impulse to endocrine cells in wall of stomach ✓ g. endocrine cells release gastrin into the blood ✓ h. gastrin induces the release of gastric juice to digest proteins ✓ i. secretin/somatostatin decrease gastrin secretion ✓		**4 max**