

Markscheme

May 2019

Biology

Standard level

Paper 3

20 pages

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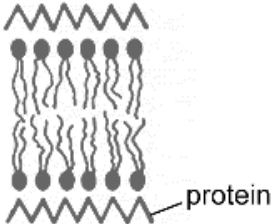
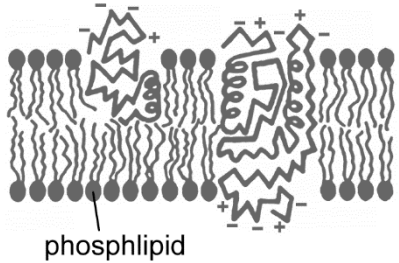
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Section A

| Question | | | Answers | Notes | Total |
|----------|---|----|---|---|-------|
| 1. | a | | Davson–Danielli ✓ | | 1 |
| 1. | b | i |  <p>protein ✓</p> <p>[Source: diagram from article published in <i>The American Journal of Pathology</i>, 65, J Singer and G Nicolson, The structure and chemistry of mammalian cell membranes, 427–437, Copyright Elsevier (1971)]</p> | Accept label to top protein. | 1 |
| 1. | b | ii |  <p>phospholipid ✓</p> <p>[Source: diagram from article published in <i>The American Journal of Pathology</i>, 65, J Singer and G Nicolson, The structure and chemistry of mammalian cell membranes, 427–437, Copyright Elsevier (1971)]</p> | Accept a label to any part of any phospholipid Accept different form of labelling that clearly indicate the phospholipids. | 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 OR supports model B ✓</p> | <p>Award any other valid conclusion.</p> <p>Do not accept "membrane is made of phospholipids".</p> | 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 ✓ | <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 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 ✓ | <i>Accept positive correlation.</i> | 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 ✓ | <i>Do not accept confusion with respirometer (measuring oxygen consumption or CO₂ 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 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» ✓ | <i>OWTTE</i> | 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 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 ✓</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>4 max</p> |

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 <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 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 |
|------------|---|---|---------------------|
| <p>11.</p> | <p>a. bacteria metabolize pollutants OR bacteria used in bioremediation OR microorganisms use pollutant as an energy source/carbon source ✓</p> <p><i>first named bacteria:</i> b. name of bacterium used in bioremediation «eg: <i>Pseudomonas</i>» ✓ c. name of pollutant/substrate «eg: oil/methyl mercury» ✓ d. product of degradation «eg: CO₂ and H₂O/elemental mercury» ✓</p> <p><i>second named bacteria:</i> e. name of bacterium used in bioremediation «eg: <i>Marinobacter</i>» ✓ f. name of pollutant/substrate «eg: benzene» ✓ g. product of degradation «eg: CO₂» ✓</p> | <p><i>Award [3 max] if two bacteria are not named</i></p> <p><i>Allow any other verified example.</i></p> <p><i>Allow any other verified example.</i></p> | <p>4 max</p> |

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» OR <i>C. montagui</i> occupies «mostly» upper shore/intertidal zone c. <i>S. balanoides</i> «mostly» occupies low tide area ✓ OR <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 OR 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 OR <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 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 | <ul style="list-style-type: none"> a. light «penetration» ✓ b. temperature ✓ c. wind ✓ d. fires ✓ | <p><i>Allow any two but mark only the first two if more are given in a list.</i></p> | 2 max |
| 14. | b | <ul style="list-style-type: none"> 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. | | <ul style="list-style-type: none"> 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 ✓ | <p><i>Accept examples for any of these marking points.</i></p> | 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 ₂ 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 two functions are required. If more than two functions are given, mark only the first two 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 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 | <ul style="list-style-type: none"> 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 ✓ | <p>Correct shape should show peaks at P R and T and dips at Q and S</p> | 3 max |
| 19. | | <ul style="list-style-type: none"> 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 |