

Markscheme

May 2018

Biology

Higher level

Paper 3

This markscheme is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of the IB Global Centre, Cardiff.

Section A

Question		Answers	Notes	Total
1.	a	9.0m ² /9m ² ✓	<i>Units required for the mark.</i>	1
1.	b	<p>a. in each quadrat determine the presence/absence «of plants» of each species ✓</p> <p>b. null hypothesis is that the presence of one is random in relation to the presence of the other plant</p> <p>OR</p> <p>alternate hypothesis is that the presence of one is associated with the presence or absence of the other ✓</p> <p>c. $x^2 = \sum \frac{(O - E)^2}{E}$ ✓</p> <p>d. accept alternative hypothesis/reject null hypothesis if the difference between observed and expected is statistically significant / $p < 0.05$ / calculated X^2 higher than tabulated X^2 / critical value</p> <p>OR</p> <p>it supports the association between the two species if the difference between observed and expected is statistically significant / $p < 0.05$ / calculated X^2 higher than tabulated X^2 / critical value ✓</p>	<p><i>Allow for a word description of the calculation.</i></p> <p><i>Accept vice versa for null hypothesis.</i></p>	3 max

Question		Answers	Notes	Total
2.	a	Li ⁺ /lithium/Li ✓		1
2.	b	a. medium acidified/more acidic ✓ b. «stomach» peptidase <u>optimum pH</u> is acid/low pH OR «pancreatic/intestinal/duodenal» peptidase <u>optimum pH</u> is alkaline/«slightly» high pH ✓ c. enzyme activity increased «for stomach peptidase» OR enzyme activity reduced «for pancreatic/intestinal/duodenal peptidase» ✓ d. change in pH causes denaturation/change in protein/enzyme structure ✓ e. by changing shape of active site ✓	OWTTE.	3 max

(continued...)

(Question 2 continued)

Question		Answers	Notes	Total
2.	c	<p>a. changes of named independent variable ✓</p> <p>b. how enzyme activity is measured ✓</p> <p>c. other variables are controlled/kept constant OR control trial/experiment ✓</p>	<p><i>Variables should be named. One example sufficient for each.</i></p> <p><i>eg use different substrate concentration.</i></p> <p><i>eg time to produce set volume of foam.</i></p> <p><i>eg temperature kept constant.</i></p>	2 max
3.	a	<p>a. measure distance «of movement» of air bubble/water in capillary tube ✓</p> <p>b. multiply by cross section of capillary ✓</p> <p>c. record/divide by time elapsed ✓</p>	<i>Allow any other valid method.</i>	2
3.	b	<p>temperature OR atmospheric pressure OR solar radiation/light OR wind speed OR leaf area OR</p>	<i>Do not accept humidity.</i>	1

			size of plant ✓		
Question			Answers	Notes	Total
3.	c		<p>a. increased «relative» humidity decreases water uptake OR inverse relationship ✓</p> <p>b. increased «relative» humidity lowers transpiration «rate» ✓</p> <p>c. diffusion gradient reduced «as humidity increases» ✓</p> <p>d. less loss of water through <u>stomata</u> OR <u>stomata</u> closed ✓</p>	<p><i>Accept inverse for dry/low humidity.</i></p>	<p>2 max</p>

Section B

Option A — Neurobiology and behaviour

Question		Answers	Notes	Total
4.	a	a. neurons initially produce multiple dendrites/prolongations ✓ b. an axon develops in response to chemical stimuli ✓		2
4.	b	a. neurons that are stimulated develop more dendrites «than those not stimulated» ✓ b. more dendrites allow for more <u>synapses</u> ✓ c. developing neurons form multiple/new <u>synapses</u> ✓ d. <u>synapses</u> that are stimulated/used many times are fortified ✓ e. neural pruning involves the loss of unused neurons/synapses ✓ f. plasticity of the nervous system allows it to change with environment/experience/to reorganize following damage OR some neurons can regenerate ✓		3 max

(continued...)

(Question 5 continued)

Question			Answers	Notes	Total
5.	a	i	cerebellum properly labelled ✓	 <p style="text-align: center;">cerebellum</p> <p>[Source: Reprinted by permission from Springer Nature: Nature, Pathways towards and away from Alzheimer's disease, Mark P. Mattson, © 2004]</p>	1
5.	a	ii	balance OR coordination OR motor control ✓		1

(continued...)

(Question 5 continued)

Question		Answers	Notes	Total
5.	b	a. «image II shows» reduction in size/volume/total amount of tissue/lobes ✓ b. «image II shows» increased space between foldings ✓ c. «image II shows» reduced surface area ✓	<i>Allow vice versa for image I.</i>	1 max
5.	c	a. reduced cognitive function/processing/memory ✓ b. reduced reward/pleasure perception ✓ c. depression ✓	<i>OWTTE.</i>	2 max
5.	d	a. brain metabolism requires large energy inputs OR glucose is the only source of energy of the brain ✓ b. «less glucose» means there is less respiration/metabolic reactions ✓ c. less cognitive/functional/synaptic activity ✓ d. some cell death ✓		2 max

Question		Answers	Notes	Total
6.	a	<p>a. maintenance metabolism/respiration of the neuron ✓</p> <p>b. use of Na-K/sodium-potassium pump to maintain resting potential ✓</p> <p>c. cell repair consumes energy ✓</p>	<p><i>Accept valid examples of metabolism, eg transcription, etc.</i></p>	<p>2 max</p>
6.	b	<p><i>S. carnaria/Sarcophaga carnaria</i> ✓</p>		<p>1</p>
6.	c	<p>a. energy consumption increases from rest to signalling «in all three species» ✓</p> <p>b. faster transmission consumes more energy</p> <p>OR</p> <p>positive correlation ✓</p> <p>c. doubling of transmission rate requires more than double the increase in energy consumption</p> <p>OR</p> <p>exponential increase</p> <p>OR</p> <p>the higher the energy consumption at rest the higher the energy consumption at signaling ✓</p>		<p>2</p>

Question		Answers	Notes	Total
7.	a	muscle «that retracts gill» ✓		1
7.	b	less neurotransmitters/dopamine are released «to the synaptic cleft by presynaptic interneurons» ✓		1
7.	c	<p>a. summation is the sum of all depolarization impulses/neurotransmitters released in the synapse/synaptic cleft of the effector/motor neuron ✓</p> <p>b. in control more excitatory than inhibitory so effect would be excitatory ✓</p> <p>c. less of each in habituated so not enough to produce action potential in the effector/motor neuron ✓</p>		2 max
7.	d	<p>a. amphetamines are stimulants ✓</p> <p>b. increases the release of dopamine in the <u>presynaptic neuron</u> ✓</p> <p>c. blocks reuptake by <u>presynaptic neuron</u> ✓</p> <p>d. more dopamine in the synaptic cleft ✓</p> <p>e. increased binding on / transmission by the <u>postsynaptic neuron</u> ✓</p>		3 max

Question	Answers		Notes	Total
8.	a. behaviour is observable impulse/reaction of an organism to «internal and external» stimuli ✓ b. exhibited behaviour results from the combination of inherited traits, experience and environment OR exhibited behaviour is a result of the combination of innate and learned behaviour ✓		Award [5 max] if no similarities are given.	6 max
	Innate behaviour	Learned behaviour		
	c. genetically inherited/instinctive d. common to all individuals of a species/not variable e. not modified by environment/over time / modified over generations f. results from natural selection g. increases chance of survival/reproduction h. example «for innate behaviour» ✓ i.	taught/based on learning/experience ✓ not common to all individuals of a species/variable ✓ modified by environment/over «short» time ✓ does not result from natural selection ✓ may or may not increase chance of survival/reproduction ✓ example «for learned behaviour» ✓		

Option B — Biotechnology and bioinformatics

Question		Answers	Notes	Total
9.	a	a. oxygen ✓ b. temperature ✓ c. pH levels ✓ d. CO ₂ ✓		2 max
9.	b	a. name of a factor ✓ b. description ✓	eg a. pH b. lowered by «ethanoic» acid production. eg a. increase in temperature b. due to metabolism. eg a. increased population size/reproduction b. would limit resources. eg a. increased metabolic waste b. causes toxic environment.	2

Question		Answers	Notes	Total
10.	a	ll ✓		1
10.	b	a. extracellular matrix does not let antibiotic enter OR has physical properties/adherence that make it hard to remove ✓ b. emergent properties may spread/cause antibiotic resistance ✓ c. quorum sensing communicates/signals to all cells ✓ d. slow reproduction rate/growth makes antibiotic less effective OR dormant cells have lower metabolic rate so antibiotic not that effective ✓ e. some bacteria escape the biofilm to colonize other areas/invade «renal» tissue ✓		3 max
10.	c	pink/red ✓	<i>Do not accept purple or violet.</i>	1

Question		Answers	Notes	Total
11.	a	<p>a. mRNA is purified from «normal and cancer» cells ✓</p> <p>b. only expressed/transcribed genes produce mRNA ✓</p> <p>c. cDNA is «a complementary DNA copy» synthesized from mRNA «by using reverse transcriptase/transcription» ✓</p>		2 max
11.	b	<p>a. red spots are genes only expressed in cancer cells ✓</p> <p>b. green spots are genes only expressed in normal cells ✓</p> <p>c. yellow spots mean that genes are expressed in both normal and cancer cells ✓</p> <p>d. red spots mean that this gene is missing/not active in normal cells OR those «red spot» genes could be promoting cancer growth ✓</p> <p>e. green spots mean that this gene is missing in cancer cells OR missing genes could be an inhibitor of cancer ✓</p>		3 max

Question			Answers	Notes	Total
12.	a	i	BLASTp OR ClustalW OR FASTA3 ✓		1
12.	a	ii	database/named database searched to compare newly identified sequences with sequences of known function in other organisms ✓		1
12.	b		a. dust mite protein has 45 % identity with CTP1 which could be unsafe ✓ b. only 36 aligned amino acids of dust mite protein which is less than the 80 danger limit ✓ c. both moth and soybean protein have less than 35% identity so are considered safe ✓ d. both moth and soybean protein have more than 80 amino acids aligned so could be unsafe ✓ e. CTP1 is not an allergen as it does not fit the criteria for any allergen OR CTP1 from the three organisms is not over the safety limit in the two categories so are considered safe ✓		3 max

(continued...)

(Question 12 continued)

Question		Answers	Notes	Total
12.	c	<p>a. a DNA sequence with a promoter, a start and a stop codon ✓</p> <p>b. start codon is ATG ✓</p> <p>c. stop codon is TAA/TAG/TGA ✓</p> <p>d. nucleotide sequence with a considerable length ✓</p> <p>e. named bioinformatics software</p> <p>OR</p> <p>ORF finder ✓</p>	<p><i>Allow other verifiable answer.</i></p>	<p>3 max</p>
12.	d	<p>a. <i>physical:</i></p> <p>electroporation</p> <p>OR</p> <p>microinjection</p> <p>OR</p> <p>biolistics «gunshot» ✓</p> <p>b. <i>chemical:</i></p> <p>calcium chloride</p> <p>OR</p> <p>liposomes ✓</p>	<p><i>Allow other verifiable answer.</i></p> <p><i>Allow other verifiable answer.</i></p>	<p>2</p>

Question	Answers	Notes	Total
13.	<ul style="list-style-type: none"> a. pollutants metabolized by microorganisms ✓ b. microorganisms useful in bioremediation because they multiply very quickly «by binary fission» ✓ c. are varied in their metabolism/inorganic reactions ✓ d. use pollutants as energy/carbon sources ✓ e. use pollutants as electron acceptors «in cellular respiration» ✓ f. bioremediation may convert heavy metals into less toxic forms «in the food chain» ✓ g. pollution incidents can involve bioremediation combined with physical/chemical procedures ✓ h. preferable to physical methods because of cost/time ✓ i. preferable to chemical methods which can leave toxic residues ✓ j. different microorganisms to be used dependent on abiotic conditions ✓ k. one named organism ✓ 		6 max

Option C — Ecology and conservation

Question		Answers	Notes	Total
14.	a	<p>a. <i>Tribolium</i> has more/greater fraction of biomass ✓</p> <p>b. «<i>Tribolium</i>» is more efficient ✓</p>		2
14.	b	<p>a. release of energy by respiration used for growth/metabolism OR energy from respiration used for maintenance ✓</p> <p>b. energy lost as heat ✓</p> <p>c. uneaten/indigestible material/exoskeleton/cellulose not digested/absorbed «not passed on to the next level» ✓</p> <p>d. energy in feces passed to saprotrophs ✓</p>		3 max
15.	a	<p>a. indirect ✓</p> <p>b. negative «effect» ✓</p> <p>c. top-down ✓</p>		2
15.	b	<p>a. sea otters have a positive «indirect» effect as sea otters feed on crabs that feed on isopods that feed on algae ✓</p> <p>b. less crabs means more isopods so less algae ✓</p> <p>c. less algae means more seagrass OR less competition between algae and seagrass ✓</p>		2 max

(continued...)

(Question 15 continued)

Question		Answers	Notes	Total
15.	c	a. the positive «bottom up» effect is due to availability of nutrients ✓ b. «nutrients» increase abundance/plant growth rates ✓ c. the negative «bottom-up» effect as excess of nutrients causes a bloom in algae growth/eutrophication/competition ✓ d. limited nutrients have negative effect on seagrass «growth» ✓ e. «excess» algae cause seagrass to die/decompose/replenish nutrients ✓	Do not accept answers referring to top down effects.	3 max

16.	a	fundamental niche is all potential conditions a species could live in whereas realized niche is actual conditions under which the species live ✓		1
16.	b	April ✓		1
16.	c	i	a. limited effect on low/stable population size from January to March ✓ b. large effect increases population size from March to April ✓ c. niche conditions decrease from January to March ✓ d. niche conditions improve from March to April ✓	OWTTE. OWTTE. 2

(continued...)

(Question 16 continued)

Question			Answers	Notes	Total
16.	c	ii	a. factor ✓ b. explanation ✓	eg temperature. eg as temperature increases in spring «March to April» so the conditions for the species are more favourable.	2

17.	a		200 m/0 to 200 m ✓		1
17.	b		a. species whose numbers/abundance are affected by a particular environmental condition OR a species used to assess a specific environmental condition ✓ b. «the presence of disturbance adapted beetles» indicates that the environment has been disturbed ✓ c. «the presence of disturbance adapted beetles» indicates that there is an edge «within 200 m» ✓		2 max

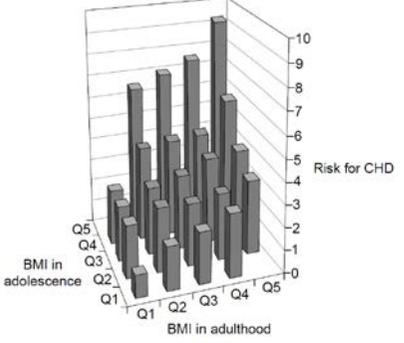
(continued...)

(Question 17 continued)

Question		Answers	Notes	Total
17.	c	<p>a. small reserve has greater edge «relative to area therefore increasing edge effect» ✓</p> <p>b. changing shape can change edge length/perimeter for a given area «therefore changing edge effect» ✓</p> <p>c. «at the edge there is» interaction of two communities</p> <p>OR</p> <p>different species may be better at invading into neighbouring community</p> <p>OR</p> <p>edge favors disturbance-adapted species ✓</p>	<p><i>Accept vice versa.</i></p> <p><i>OWTTE.</i></p>	<p>3 max</p>

Question	Answers	Notes	Total
18.	<p>a. name of alien species AND where introduced ✓</p> <p>b. how/reason alien species was introduced OR «expected» benefit for species being introduced ✓</p> <p>c. introduced alien species can escape into local ecosystems OR how it became invasive ✓</p> <p>d. «reference to principle of» competitive exclusion OR take over the niche of other organisms ✓</p> <p>e. can reproduce more than native species ✓</p> <p>f. relationship with predators ✓</p> <p>g. reduction in the numbers of endemic species / decrease in biodiversity ✓</p> <p>h. description of another effect on this alien species ✓</p>	<p><i>Mark only the first example provided if more than one.</i></p> <p><i>Impacts must relate to named species.</i></p>	6 max

Option D — Human physiology

Question		Answers	Notes	Total
19.	a	<p><i>Hypothesis supported as:</i></p> <p>a. all subjects with a high BMI «in Q5» in adolescence had a high risk of CHD «>6», even when BMI in adulthood was low «in Q2» ✓</p> <p>b. subjects with a high BMI in adulthood «Q4 and Q5» had a much higher risk of CHD if they also had a high BMI in adolescence ✓</p> <p>c. high BMI in both adolescence and adulthood increases risk ✓</p>	<p>OWTTE.</p> <p>OWTTE.</p> <p>Accept any other valid answer based on the graph.</p>  <p>[Source: From The New England Journal of Medicine, A Tirosh et al, Adolescent BMI Trajectory and Risk of Diabetes versus Coronary Disease, 364, 1315. Copyright © (2011) Massachusetts Medical Society. Reprinted with permission from Massachusetts Medical Society]</p>	2 max

(continued...)

(Question 19 continued)

Question		Answers	Notes	Total
19.	b	increased triglycerides/cholesterol in the blood OR presence of plaque/atherosclerosis «in arteries» OR high blood pressure/hypertension OR sedentary lifestyle/lack of exercise OR genetic/hereditary factor OR smoking OR age OR diet ✓		1 max

Question		Answers	Notes	Total
20.	a	<u>stomach</u> ulcer OR <u>stomach</u> cancer ✓		1
20.	b	a. sight/smell/«presence of» food in stomach stimulates nervous system ✓ b. nervous system/vagus nerve stimulates gastric glands «to produce gastric acid» ✓ c. gastrin controls release of gastric acid ✓ d. parietal cells «are stimulated to» release gastric/hydrochloric acid/HCl ✓ e. acidity maintained by the proton pump/H ⁺ /K ⁺ ATPase ✓		2 max
20.	c	a. as proton pumps are inhibited less protons/H ⁺ into stomach «lumen» ✓ b. «less protons/H ⁺ in stomach» less hydrochloric acid produced ✓ OR stomach «contents» become less acidic ✓ c. stomach heals with higher pH ✓	OWTTE.	2 max

21.	a	the proportion/percentage increases «from 45 % to 70 %» ✓		1
21.	b	a. more erythrocytes/hemoglobin produced to compensate ✓ b. low oxygen «partial» pressure «at high altitude» ✓ c. lower oxygen saturation «of hemoglobin at high altitude» ✓ d. less oxygen carried to tissues/hypoxia ✓		2 max

(continued...)

(Question 21 continued)

Question		Answers	Notes	Total
21.	c	a. induced conformational change in the structure of the hemoglobin molecule occurs ✓ b. «this» hemoglobin has higher affinity for oxygen ✓ c. saturation curve shifted to the left «because of low O ₂ levels» ✓ d. «this» hemoglobin becomes more saturated at lower partial pressures of oxygen ✓ e. increased hematocrit/concentration of hemoglobin/red blood cells to carry more O ₂ ✓	Allow answers in an annotated diagram.	3 max
21.	d	a. phagocytosis of erythrocytes by Kupffer cells ✓ b. hemoglobin is split into globin and heme group ✓ c. globin is re-used in protein synthesis ✓ d. heme group broken down into iron and bilirubin ✓ e. iron is carried back to the bone marrow «to produce new hemoglobin/erythrocytes» ✓		3 max

Question		Answers	Notes	Total
22.	a	a. state the method/equipment ✓ b. how method/equipment works ✓ c. during exercise on treadmill/bicycle ✓	eg take the pulse. eg count beats per minute. OWTTE.	2
22.	b	a. muscles become less elastic OR less muscle tone ✓ b. cells/mitochondria less efficient ✓ c. more fat deposits OR blood/oxygen supply to heart tissue reduced ✓	Accept other valid documented answers.	2 max
22.	c	a. defibrillator is electrodes/a metal paddle/pad that is placed on the patient's chest ✓ b. the device determines whether fibrillation is happening ✓ c. a series of electrical shocks are delivered through the electrodes ✓ d. electrical impulse is used to depolarize the heart muscle ✓ e. to re-establish the function of the SA node/natural pacemaker/natural rhythm «of the heart» ✓		3 max

Question	Answers	Notes	Total
23.	<p>a. both «peptide and steroid hormones» act on target organs/cells ✓</p> <p>b. both «peptide and steroid hormones» travel through blood ✓</p> <p>c. the effect of both «peptide and steroid hormones» lasts for a longer time «than neurotransmitters»</p> <p>OR</p> <p>both are effective at very low concentrations ✓</p> <p>d. example of each type of hormone ✓</p> <p>e. steroid hormones enter cell/cross plasma membrane while peptide hormones do not ✓</p> <p>f. steroid hormones join receptor in cytoplasm while peptide hormones join receptor on membrane ✓</p> <p>g. steroid hormone-receptor complex travels to nucleus whereas peptide hormone-receptor triggers a cascade reaction/second messenger ✓</p> <p>h. steroid hormones activate genes while peptide hormones activate enzymes ✓</p> <p>i. peptide hormone requires ATP, steroid hormone does not ✓</p>	<p><i>Award [5 max] if no similarities are presented.</i></p>	<p>6 max</p>