Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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Biology

Higher level

Paper 3

28 pages

Section A

Question			Answers	Notes	Total
1.	a		a. in NaCl concentrations between 0.3 to 0.5 % venom increases the percentage of hemolysis/more cells lyse ✓ b. venom has no effect below 0.3% and above 0.55% NaCl ***OR*** Venom has no effect at very low or very high NaCl concentrations ✓		**2**
1.	b		a. weigh all pieces to ensure same amount of plant material/allow comparisons ✓ b. control surface area by having same shape/ size ✓ c. carry out experiment at same temperature e.g. using a water bath or constant room temperature ✓ d. all samples in solution for same length of time ✓ e. all samples from same plant (to minimize variability) ✓ f. use a range of solutions of the same solute ✓ g. constant method of removing excess fluid before weigh tissue samples ✓	*Do not accept just a list of controlled variables.*	**3**

Question			Answers	Notes	Total
2.	a		spirometer ✓		1
2.	b		a. tidal volume x ventilation rate ***OR*** litres breath^{-1} x breath min^{-1} ✓ b. 186 L (min^{-1}) ✓		2
2.	c		a. both ventilation rate and tidal volume increase with increase in treadmill speed / intensity of exercise ✓ b. at low treadmill speed/below 14.2 kmh^{-1}, the tidal volume increases more steeply than ventilation rate ***OR*** at high treadmill speed, ventilation rate increases more steeply than tidal volume ***OR*** tidal volume plateaus while ventilation rate does not ✓		2

Question			Answers	Notes	Total
3.	a		a. the research question identifies the independent variables ✓ b. the research question identifies the dependent variable/derived value ✓ c. the research question identifies the organism tested ✓	*If several variables are given, mark the first one only.* *Examples:* *a. Effect of changing/increasing wind/temperature/light/humidity/surface area /comparing different species* *b. accept transpiration rate* *c. accept common names.*	**2**
3.	b		a. not all of the water taken up by the plant is used for transpiration ✓ b. some water taken up might be used for photosynthesis/ cell turgidity ✓ c. (bubble) potometer measures rate of water uptake (not transpiration directly) ***OR*** bubble in potometer may expand due to changes in temperature/pressure✓ d. (cut) plant/twig gets damaged/may not survive ✓ e. conditions in a lab are not equivalent to those in nature/ difficult to change only one abiotic factor ✓ f. Difficult to extrapolate values from a twig to whole plant ✓		**3**

Section B

Option A — Neurobiology and behaviour

Question			Answers	Notes	Total
4.	a		a. neural plate moves/folds/bends inwards to form a groove ✓ b. cells multiply/edges increase in height ✓ c. borders/edges of neural plate join/form neural crest ✓ d. neural tube forms/separates from rest (of ectoderm) ✓		2
4.	b		a. spine/spinal cord does not form properly ***OR*** incomplete closure of embryonic neural tube/ tissues around the neural tube do not fuse ✓ b. lack of folic acid/folate (B9 vitamin) in pregnancy ✓ c. genetic/family history ✓ d. exposure to certain medication/environmental conditions during pregnancy ✓		2
4.	c		a. development of vertebrate nervous system results in overabundance of neurons/connections ✓ b. unused neurons/synapses are lost ✓ c. neurons destroy themselves by programmed/natural cell death/apoptosis ✓ d. removal of dendrites from neurons ✓		2

Question			Answers	Notes	Total
5.	a	i	learning / memory /emotions / language / other correct function ✓		1
5.	a	ii	a. humans have a (much) larger ratio of cerebral cortex mass compared to body size/mass than elephants✓ b. humans have higher number of (cortex) neurons (than elephants)/vice versa ✓ c. larger number of neurons (in cortex) leads to higher intelligence (as cortex is site of functions associated with intelligence) ✓ d. other factors not shown in the table may determine to intelligence ✓		2
5.	b		a. brain cells/neurons carry out large amount of metabolic activity ✓ b. maintenance of resting potential requires energy/ATP ***OR*** functioning of Na-K pumps requires energy/ATP ✓		1
5.	c		a. (measures brain activity by) detecting changes associated with blood flow ✓ b. more active parts of brain receive more blood flow ✓ c. activity leads to change in magnetization between oxygen-rich and oxygen-poor blood ✓ d. scans/images are taken while the subject is exposed to a stimulus/activity ✓		2

Question			Answers	Notes	Total
6.	a	i	mechanoreceptor ✓		1
6.	a	ii	a. permanent injury/loss of <u>hair cells / sensory hairs</u> in cochlea ✓ b. damage to bones in the middle ear / damage the connections between the ossicles ✓ c. ruptured eardrum ✓		1
6.	b		a. (3) semicircular canals are perpendicular/at right angles/help sense movement ✓ b. movement (of head) causes fluid in canals/inner ear to move ✓ c. deflects/bends <u>hair cells</u> ✓ d. (Hair cells) send messages to brain via auditory nerve ✓		2

Question			Answers	Notes	Total
7.	a		benzodiazepines / alcohol / THC /barbiturates ✓		1
7.	b		***EITHER*** a. genetic predisposition ✓ b. metabolic/enzyme differences (e.g. in processing of alcohol) ✓ ***OR*** a. dopamine secretion ✓ b. addictive drugs trigger (higher) secretion/extracellular levels of dopamine (which causes positive effect on mood) ✓		2
7.	c		a. innate behaviour is controlled by genes/inherited while learned is not inherited ✓ b. the early birdsong pattern is genetically determined/innate ✓ c. learned behaviour occurs as a result of experience while innate is independent of environment ✓ d. (Later) birds modify their (early) song pattern based on learning from adults/other birds/the environment ✓	*Note that mpa and mpc have two parts that are both required for the mark to be awarded. They are comparisons.*	3

(continued…)

(Question 7 continued)

Question			Answers	Notes	Total
7.	**d**		a. named animal and traditional behavior ✓ b. natural selection pressure with resulting animal response ✓	*Accept common or general names of organisms.* *Examples of change in colour (peppered moth) are <u>not</u> behavioural changes.* *Example:* *a. blackcap/warbler migrates to Spain* ✓ *b. warmer winters in UK / more food resulting in selection of those migrating to UK / increased numbers / greater survival* ✓ ***OR*** *a. native green lizards traditionally occupy the lower branches and trunks of Florida's trees* ✓ *b. now live in upper branches due to pressure caused by competition of Invasive brown lizard (Over 20 generations/15 years developed sticky foot pads to hold on to smoother branches)* ✓ ***OR*** *a. House finches in California are sedentary/do not migrate* ✓ *b. Introduced into New York (about 1940) and increasing numbers migrate south during the winter months to warmer conditions/more food* ✓	**2**

Question			Answers	Notes	Total
8.			a. (white) light is a mix of different wavelengths which correspond to different colours seen ✓ b. light hits the back of the eye /retina ✓ c. cones are photoreceptors in the retina/concentrated in fovea ✓ d. cone cells are sensitive to a specific wavelength/specific colours/contain different pigments ✓ e. three types of cone cells respond to red, blue or green light ✓ f. different colours are perceived by the relative degree of stimulation of different cone cells ✓ g. single cone cell passes impulses to a single nerve fibre/ganglion cell ✓ h. (stimulation of) cones require bright light/ colour vision is less in dim light ✓ i. genetic disorders can cause absence of red/green/some pigments / colour blindness ✓		**6**

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
9.	a	i	methane / biogas ✓		1
9.	a	ii	a. anaerobic conditions / prevent entry of oxygen ✓ b. warm temperatures / temperature above 15°C ✓ c. different communities of microorganisms / Eubacteria and methanogens ✓ d. proper pH needs to be maintained ✓		1
9.	b		a. changes of pH (possibly caused by changes of CO_2) affect enzyme activity ✓ b. ambient pressure / build-up of gases may affect reactions involving gases ✓ c. increase of temperature could affect reaction rates /denature enzymes ✓ d. decrease in nutrients/raw materials/change in substrate could decrease rate of product formation e. increase in wastes could decrease rate of metabolism ✓ f. particle size affects rate of fermentation associated with surface area (for substrate interactions) ✓ g. mixing is necessary as sedimentation lowers surface area thus decreasing rate of reactions ✓		3
9.	c		I. peptidoglycan ✓ II. outer membrane/layer of lipopolysaccharide and protein ✓ III. peptidoglycan ✓		3

Question			Answers	Notes	Total
10.	a		a. large increase in (percentage of area planted with) genetically modified corn ✓ b. Bt and HT together hardly/not planted in the year 2000 but is majority of corn planted in 2015 ✓ c. HT alone has slightly increased while Bt alone has decreased ✓ d. all 3 types of corn were planted in both 2000 and 2015 ✓		2
10.	b		a. insect-resistant crops contain genes from the soil bacterium (*Bacillus thuringiensis*) Bt ✓ b. herbicide (glyphosate) resistance gene has been introduced in plants ✓ c. (resistance genes introduced) by vectors / physical methods / chemical methods ✓ d. successfully modified plants are selected for further propagation ✓		2

Question			Answers	Notes	Total
11.	a	i	«a biofilm is» any group of microorganisms in which cells stick to each other on a surface ***OR*** «a biofilm is» any group of microorganisms in which cells cooperatively produce a polysaccharide matrix ✓		1
11.	a	ii	a. biofilms show properties that are not shown by the individual cells / biofilms develop emergent properties ✓ b. quorum sensing changes microbial behaviour/production of matrix ✓ c. (matrix) hard to remove from a surface ✓ d. biofilms are tolerant to desiccation and heat shock ✓ e. biofilms may be very resistant to the action of (many) antibiotics/antimicrobial agents ✓ f. because cell division in biofilms is slow, antibiotics targeting this will be ineffective ✓ ***OR*** matrix forms a barrier to antibiotics ✓		3

(continued…)

(Question 11 continued)

Question			Answers	Notes	Total
11.	**b**		a. (bioremediation is the) use of microorganisms to consume/break down pollutants ✓ b. name of bacterium (genus required) and contaminating substance ✓ c. outline one action of (this) bacterium to remove environmental contaminants from water or soil ✓ d. another detail of use of (this) bacterium to remove the contaminant ✓ e. advantage/disadvantage of using this bacterium ✓	*b. e.g. some Pseudomonas to remove oil spills* ✓ *c. uses crude oil for energy / breaks down crude oil* ✓ *d. e.g. bacteria also need other chemicals/process may be speeded up by adding essential inorganic nutrients (phosphates/nitrates)* ✓ *OR* *b. e.g. Pseudomonas used to remove methyl mercury* ✓ *c. bacteria (Pseudomonas) degrade methyl mercury into elemental mercury and methane* ✓ *d. methyl mercury is very toxic / can be biomagnified in food chain* ✓	**3**

Question			Answers	Notes	Total
12.	a		a. organisms with similar gene sequence could be used as models for specific gene functions (in humans) ✓ b. it is possible for researchers to learn about the gene function faster/more easily as fewer genes (in model) ✓ c. can predict effects in other organisms ✓ d. some research may be unethical in humans ✓		2
12.	b		a. results from BLASTn or BLASTp /genomic or proteomic sequences can be used ✓ b. compared with data from available organisms ✓ c. matches based on the number of similarities in the sequence are identified ✓ d. similarities in sequence may be caused by evolution or by chance ✓ e. computer programs (use sequence alignments) to suggest evolutionary relationships / cladograms can be constructed ✓		3

Question			Answers	Notes	Total
13.			a. used on genetic diseases caused by defective genes/lack of enzyme/ protein ✓ b. viral vector (genetically) modified for (safe) use ✓ c. virus genome is altered and missing gene/allele is introduced into virus ✓ d. a retrovirus is used to introduce <u>RNA</u> and <u>reverse transcriptase</u> in a host cell ✓ e. RNA is copied into DNA and introduced (permanently) into the cells genome ✓ f. could use adenovirus/virus with DNA to introduce genetic material ✓ g. in this technique DNA is not attached to cell genome ✓ h. thus not replicated during host cell replication / treatment has to be repeated ✓ i. it could be done in somatic treatment (body cells) or in sex cells (egg cells) ✓ j. example (*ie* Gendicine, is an adenovirus used for treatment of head and neck cancer) ✓		6

Option C — Ecology and conservation

Question			Answers	Notes	Total
14.	**a**		a. keystone species has a strong/disproportionate effect on a community/food web/ecosystem ✓ b. absence of keystone species would completely alter the ecosystem ✓		**1**
14.	**b**		a. example of mutualistic species ✓ b. description of mutualism ✓	*Accept commonplace names for organisms in (a)* *Examples:* *a. oxpecker (bird) and the rhinoceros/zebra ✓* *b. oxpeckers/bird on rhinos/zebras eat parasites getting food while rhino/zebra get pest control* ***OR*** *a. hummingbird hawk-moth and Dianthus ✓* *b. (hummingbird hawk) moth gets nectar from flower while it pollinates the flower ✓*	**2**
14.	**c**		fundamental is the potential (niche) and realized is the actual (niche) ✓	***OWTTE***	**1**

Question			Answers	Notes	Total
15.	a		temperature/precipitation/rainfall/minerals /pH of soils/light/humidity/wind/slope (in this specific example) ✓		1
15.	b		a. (bare ground) colonized by microorganisms/pioneer species ✓ b. thin soil forms from rock fragments / decomposing organisms ✓ c. soil retains water from melting permafrost/ice ✓ d. grasses/small plants/herbaceous plants/moss grow ✓ e. (larger plants) create habitat for animals ✓ f. weather/climate may limit plant size/biodiversity ***OR*** climax community forms ✓		3
15.	c		*Similarities*: a. in both food webs and chains organisms are arranged by trophic levels/feeding positions ✓ b. both represent the transfer of food/energy in an ecosystem ✓ c. both include producers and consumers ✓ *Differences*: d. one species could occupy different trophic levels in a food web but not in a food chain / converse ✓ e. food chain represents one possible feeding option for each organism but food web represents more possible feeding relationships/trophic levels ✓	***OWTTE*** *(max 1 for similarities)* *(max 1 for differences)*	2

Question			Answers	Notes	Total
16.	a		organisms that are introduced (accidentally or deliberately) **and** negative environmental consequences ✓	***OWTTE***	**1**
16.	b		a. inter-specific competition/alien species may out-compete native species ✓ b. lack of predators may allow alien species to thrive / reproduce more rapidly ✓ c. alien species may utilize areas/ resources that native species cannot ✓ d. predation by invasive species can cause loss of biodiversity ✓ e. can lead to species extinction ✓ f. alien species may introduce new diseases ✓ g. global shipping/air travel allows rapid transfer of alien species to new ecosystems ✓		**3**

(continued…)

(Question 16 continued)

Question			Answers	Notes	Total
16.	**c**		a. specific name of invasive alien species to be controlled and where (in general) ✓ b. method of biological control with specific name of predator/parasite/pathogen ✓	*Examples must be verified.* *a. rabbits introduced into Australia* ✓ *b. controlled by release of myxoma virus / myxomatosis (from South America)* ✓	**2**
16.	**d**		a. organisms may get tangled in plastic debris ✓ b. animals accidentally eat plastic mistaking it for food/feed plastic pieces to offspring ✓ c. (floating) plastic debris can block sunlight preventing photosynthesis ✓	*(allow any other reasonable example)*	**1**

(continued…)

(Question 16 continued)

Question			Answers	Notes	Total
16.	**e**		a. chemicals (non-degradable) accumulate along the food chain becoming more concentrated at each successive trophic level ✓ b. negative effects of organisms high in food chain ✓ c. toxic effects/death/ thin egg shells/other valid example ✓	*Accept specific examples of chemicals.*	**2**

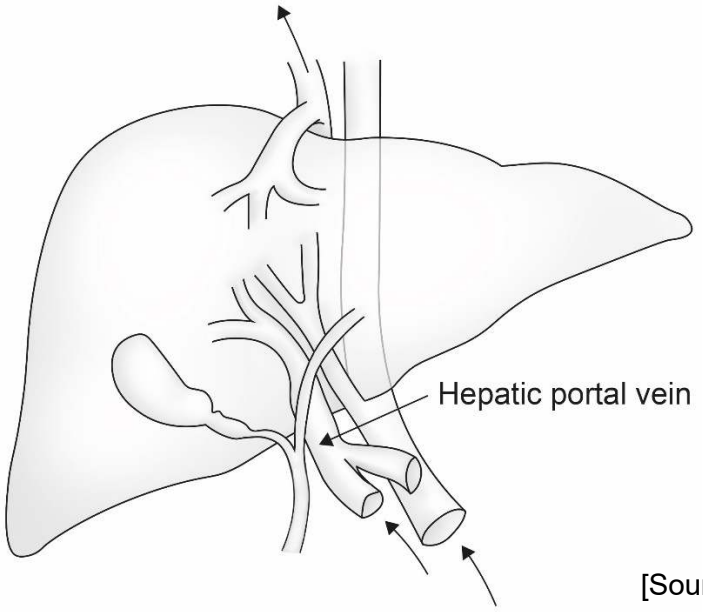
17.	**a**	**i**	exponential «population growth» ✓		**1**
17.	**a**	**ii**	lack of food / disease / hunting / increase of predators ✓		**1**
17.	**b**		a. large area can support greater range of habitats / longer food chains / higher population numbers ✓ b. low edge effect with circular reserves ***OR*** reduced edge effect minimises area that is disturbed/competition ✓ c. intact / unbroken areas represent less disturbance on habitats ✓ d. fragmented areas linked by corridors ✓ e. (proximity of fragmented areas) allows for animal movement / genetic exchange ✓		**3**

Question			Answers	Notes	Total
18.			a. phosphorus in rock (reserves) enters slowly into the biosphere by weathering ✓ b. mining of phosphorus (-bearing) rocks accelerates the natural cycle/faster than natural erosion ✓ c. (mined) phosphorus is made into fertilizers/animal feeds/other products ***OR*** artificial fertilizers contain phosphate ✓ d. (phosphorous products) transported to agricultural areas (all over the world) ✓ e. with use of fertilizers phosphorus makes its way into the soil ✓ f. run-off/drainage from farms causes phosphorus to move into aquatic ecosystems ✓ g. use of detergents adds phosphorus to water ✓ h. release of sewage adds phosphorus to water ✓ i. excess phosphorus can lead to over growth of algae and plants in water ✓ j. decomposition of dead plant material (by bacteria) use up all the oxygen in the water/increase BOD ***OR*** decomposition of dead plant material causes eutrophication ✓ k. «eutrophication» can kill fish and other plants / is negative for ecosystems ✓ l. phosphorus removed (from ecosystem) by the harvesting of agricultural crops ✓		**6**

Option D — Human physiology

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>19.</td><td>a</td><td>i</td><td>are essential for health / cannot be synthesized by humans ✓</td><td>Vitamin D is altered from a precursor.</td><td>1</td></tr>
<tr><td>19.</td><td>a</td><td>ii</td><td>does not mention whether the information is based on adults/children/age
OR
only two vitamins are shown/no quantities given for vitamins
OR
it does not take into consideration sex / pregnancy / activity levels ✓</td><td>Accept other valid correct limitation.</td><td>1</td></tr>
<tr><td>19.</td><td>b</td><td></td><td>
<table>
<tr><th>Gastric juice</th><th>Pancreatic juice</th></tr>
<tr><td>a. produced by glands in stomach wallAccept as an alternative to mpa:</td><td>produced by pancreas ✓</td></tr>
<tr><td>b. low pH / acidic</td><td>high pH / alkaline ✓</td></tr>
<tr><td>c. contains hydrochloric acid</td><td>contains HCO_3- ✓</td></tr>
<tr><td>d. no enzymes for lipid/starch digestion</td><td>lipase/amylase ✓</td></tr>
<tr><td>e. contains mucus</td><td>no mucus ✓</td></tr>
</table>
</td><td>Each row must be a distinction</td><td>3</td></tr>
<tr><td>19.</td><td>c</td><td></td><td>a. steroid hormones enter cell / steroid hormones can pass through cell membranes ✓
b. steroid hormones bind to receptor in the cytoplasm ✓
c. the receptor-hormone complex interacts directly with genes/regulates gene expression ✓
d. example (e.g. oestrogen, testosterone, progesterone) ✓</td><td></td><td>3</td></tr>
</table>

(Question 19 continued)

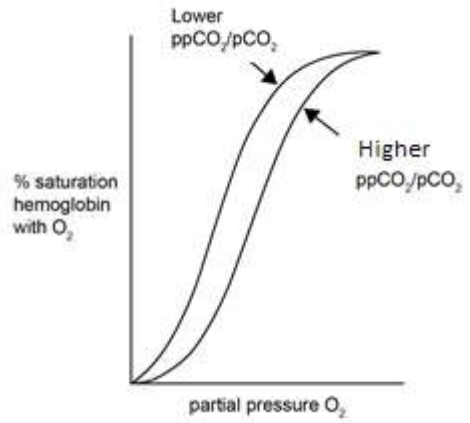
Question			Answers	Notes	Total
19.	**d**		a. provides ideal pH for stomach enzyme activity ✓ b. (acidic conditions) denature proteins /start breakdown of other organic substances ✓ c. (acidic conditions) convert pepsinogen (inactive) into pepsin ✓ d. (acidic conditions) destroy pathogens in ingested food ✓		**2**
20.	**a**	**i**	 [Source: VectorStock]	*Accept the vessel labeled (hepatic portal vein) as it ends in the liver and does not continue. A label anywhere on the vessel or pointing to the arrow underneath it is acceptable.*	**1**

(continued…)

(Question 20 continued)

Question			Answers	Notes	Total
20.	**a**	**ii**	a. hepatic artery carries oxygenated blood (from the aorta) ✓ b. hepatic portal vein carries (deoxygenated) blood from digestive tract ✓ c. blood from hepatic portal vein and hepatic artery mixes ✓ d. flows through sinusoids ✓ e. hepatic vein carries blood away from liver/to heart ✓		**3**
20.	**b**		a. hemoglobin absorbed by phagocytes/Kupffer cells ✓ b. split into heme and globin ✓ c. globin hydrolysed/broken down to amino acids ✓ d. iron removed from heme group / heme broken down to form bilirubin/bile pigment ✓		**3**

Question			Answers	Notes	Total
21.	a		a. initiates action potentials / electrical impulses (at start of cardiac cycle) ✓ b. acts as pacemaker/ continuous beating without external stimuli ✓ c. signal spreads over atria / causes contraction of atria (systole) ✓ d. impulses transmitted to AV (atrioventricular) node / cannot pass directly to ventricles ✓		2
21.	b	i	a. data show correlation (increased chance of CHD with age) not causation ✓	***OWTTE***.	1
21.	b	ii	sex / ethnic group / genetics / obesity / diet / life style / medical history / high cholesterol levels ✓	*Smoking / stress go under lifestyle.*	1
21.	c		a. deposition of fat in arteries thus losing elasticity/forming fibrous tissues ✓ b. deposition of fat/formation of plaque in arteries thus narrowing of lumen/causing a blockage ✓ c. high salt levels in diets thus retaining more fluids ✓ d. smoking because nicotine is a vasoconstrictor molecule ✓ e. prolonged high levels of stress thus causing vasoconstriction / exposure to stress hormones ✓ f. genetic predisposition makes it more likely that other factors will lead to hypertension ✓	*Do not accept a list.*	3

Question			Answers	Notes	Total
22.			a. cell respiration consumes O_2 / lowers O_2 partial pressure in tissues b. (actively) respiring tissues release CO_2 / partial pressure of CO_2 increases ✓ c. CO_2 increases acidity / lowers pH of the blood ✓ d. decreases hemoglobin's affinity for O_2 ✓ e. promotes the release of oxygen to respiring cells/tissues ✓ f. binding of hydrogen ions/ allosteric effect / conformational change in hemoglobin releases O_2 more readily ✓ g. more oxygen released at the same partial pressure ✓ h. this shifts the oxygen dissociation curve to the right/Bohr shift ✓  *diagram with correct labels:* i. partial pressure O_2 on x-axis <u>and</u> (percentage) saturation hemoglobin with O_2 on y-axis ✓ j. exponential shape curve at lower partial pressure/concentration of O_2 ✓ k. curve shifted to right (and lower) for higher partial pressure /concentration of CO_2 /lower pH ✓	*These points can be presented in a graph.*	**6**