Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2018

Biology

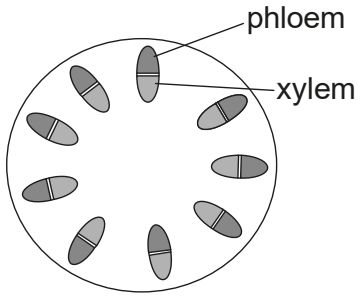
Higher level

Paper 3

23 pages

Section A

Question			Answers	Notes	Total
1.	a		12 breaths per minute/6 litres per minute ✓	*Accept answers from 11 to 12 breaths per minute.* *Accept answers from 5.5 to 6 litres per minute.* *Answer must include breaths or litres and a standard unit of time.* *Correct:* *eg: 12 breaths / minute* *eg: 0.1 L sec^{-1} or 6 L min^{-1}* *Incorrect:* *eg: but 12 breaths = 0 marks*	**1**
1.	b		a. the volume of air per breath increases ***OR*** the volume of each breath reaches a maximum/levels off ***OR*** frequency of ventilation/breaths per minute increases ✓ b. exercise increases **«**rate of cellular**»** respiration/energy use/blood CO_2/acidity ✓ c. exercise causes increased demand for oxygen/removal of carbon dioxide ✓ d. maximum rate/depth of ventilation is determined by the capacity of the student ✓		**2 max**
1.	c		**«**total resting lung volume**»** would be greater ✓		**1**
1.	d		a. type I pneumocytes carry out gas exchange ✓ b. type II pneumocytes secrete surfactant/fluid ***OR*** type II pneumocytes create a moist surface inside the alveoli ***OR*** type II pneumocytes reduce surface tension between alveoli ***OR*** type II pneumocytes prevent the sides of the alveolus adhering to each other ✓	*OWTTE* *OWTTE*	**2**

Question			Answers	Notes	Total
2.	a		a. *X*: phloem ✓ b. *Y*: xylem ✓		2
2.	b		A-B = $\frac{7\text{ mm}}{400}$ ***OR*** 17.5 μm ✓	*Accept answers in the range of 17 to 19 μm*	1
2.	c		a. stem vascular tissue is in bundles ✓ b. **«**bundles**»** form a ring c. phloem is towards outside **«**of bundle**»** ***OR*** xylem is towards centre **«**of bundle**»** ✓	*Allow answers in an annotated drawing*  	2 max

Question			Answers	Notes	Total
3.	a		X ***AND*** Y ✓	*Both needed*	1
3.	b		W ***AND*** X ✓	*Both needed*	1
3.	c		*pro (yes, it could be evidence)* a. starch is a product of photosynthesis ✓ *con (not necessarily evidence)* b. starch could be made elsewhere «in the plant» and transported to/stored in leaves ***OR*** starch could be made by another process «other than photosynthesis» ***OR*** starch is being detected although glucose is the direct product ✓ *limitations of experiment* c. starch depletion may take more than 24 hours «of dark» ***OR*** starch production may take more than 6 hours «of light» ***OR*** starch should have been measured before and after ✓	 *OWTTE* *OWTTE* *OWTTE* *OWTTE* *OWTTE* *OWTTE*	2 max

Section B

Option A — Neurobiology and behaviour

Question			Answers	Notes	Total
4.	a		a. «the process shows» the growth of an axon/dendrites/extensions ✓ b. differentiation/forming a specialized neuron ✓ c. responding to a chemical stimulus ✓		2 max
4.	b		a. the neuron forms synapses/multiple connections «with other neurons» ***OR*** a neural network forms ***OR*** more dendrites ✓ b. some synapses/connections in excess of what is required ***OR*** some synapses/connections not used ✓ c. it could be removed by neural pruning/apoptosis ✓ d. it could migrate to another place ✓		2 max
4.	c		a. allows brain to change/adjust/make new synapses throughout lifetime/with experience/learning ✓ b. allows regeneration of neurons after brain trauma ***OR*** allows other areas «of the brain» to take over a function after brain trauma ✓ c. selective advantage/increases chance of survival ✓	*OWTTE*	1 max

Question			Answers	Notes	Total
5.	**a**		*similarity*: a. as body size increases, brain volume increases for smaller mammals ***OR*** «weak» positive correlation ✓ *contrast*: b. humans do not fit the trend/are the exception ✓		**2 max**
5.	**b**		a. human cortex has a larger total volume/is larger than gorilla's ✓ b. human cortex has more folding/area «to accommodate within the cranium» ✓		**1 max**
5.	**c**	**i**	speech production/language processing ✓		**1**
5.	**c**	**ii**	cognitive processing of motivation/pleasure/reward ***OR*** modulates the effects of «the neurotransmitter» dopamine ***OR*** involved in learning ✓		**1**
5.	**c**	**iii**	swallowing/breathing/heart rate/digestion/sneezing/coughing/vomiting ✓		**1**

Question			Answers	Notes	Total
6.	**a**		a. with each trial the drawings get better/less errors ***OR*** each day the patient becomes better at drawing the star ✓ b. by day 3 the patient makes few mistakes/less fluctuations ✓ c. even though left hand went through fewer trials, still an improvement ✓ d. practice improves the behaviour ***OR*** learning occurs «over time» with repetition ✓		**3 max**
6.	**b**		right handed, as the patient made fewer mistakes with this hand ***OR*** right handed as fewer trials with left hand ***OR*** not possible to draw conclusion as the trends are the same for both but left hand trials end after a few trials ✓	*Must give reason for the mark* *OWTTE*	**1**
6.	**c**	**i**	a. learning by trial and error ***OR*** reward/punishment to reinforce behaviour ✓ b. example ✓	*eg: mice given food when finding their way across a maze will perform better the second time*	**2**
6.	**c**	**ii**	a. a form of learning where the young animal fixes its attention on the first object seen ✓ b. example ✓	*eg: a duckling seeing a human after hatching will follow that human*	**2**

(*continued...*)

(Question 6 continued)

Question			Answers	Notes	Total
6.	**d**		a. slow-acting neurotransmitters affect learning/memory ✓ b. **«**slow-acting neurotransmitters**»** trigger the release of secondary messengers **«**in postsynaptic neuron**»** ✓ c. synaptic transmission is enhanced ***OR*** increase in the number of receptors in the postsynaptic membrane ✓ d. modulate/reduce/increase fast synaptic transmission **«**in the brain**»** ✓		**2 max**

7.			a. males' long feathers/plumage/bright colours attract mate ***OR*** dance/vocalizations attract mate ✓ b. males compete for the females to reproduce ✓ c. characteristics also make males more vulnerable to predation ✓ d. males survive despite having huge tails/extreme features ✓ e. **«**natural selection**»** has benefited the most colourful/attractive males with best reproductive success/fitness/passing genes to offspring ✓	*OWTTE*	**3 max**

Question			Answers	Notes	Total
8.				*Allow answers in annotated diagrams*	**6 max**
			a. photoreceptors/cones/rods detect «reflected» light/stimulus ✓		
			b. cones found in fovea «of retina» and rods found all over retina ✓		
			c. rods active in low-intensity/dim light ✓		
			d. cones active in high-intensity/bright light ✓		
			e. rods give black and white vision ✓	*OWTTE*	
			f. cones detect colours ✓	*OWTTE*	
			g. bipolar neurons/cells synapse with multiple rods but «only» with individual cones ✓	*OWTTE*	
			h. bipolar neurons/cells «in the retina» form synapses with ganglion cells ✓		
			i. electrical/nerve impulses travel to brain/occipital lobe via the optic nerve ✓		
			j. right field of vision from both eyes sent to the left part of the visual cortex through the chiasma «and vice versa» ✓		

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
9.	**a**		a. bacteria/*B. subtilis* adhere to surfaces ✓ b. **«**bacteria/*B. subtilis***»** grow surrounded by EPS/exopolysaccharide/extracellular polymeric substance matrix ✓ c. **«**bacteria/*B. subtilis* growing in a biofilm**»** are highly resistant to antimicrobial agents ✓ d. **«**bacteria/*B. subtilis* in biofilms**»** cooperate through quorum sensing ✓		**2 max**
9.	**b**		a. example of where biofilm cause problems ✓ b. description of problems ✓	*eg: clogging/corrosion of pipes/water systems* ✓ *slows down/interrupts/clogs water supply systems* ✓ ***OR*** *eg: contamination of surfaces in food production* ✓ *causes food transmitted diseases* ✓ ***OR*** *eg: plaque formation on teeth* ✓ *causes cavities* ✓ ***OR*** *eg: catheter clogging* ✓ *causes urinary infections* ✓	**2 max**

Question			Answers	Notes	Total
10.	a		bacteria ***OR*** archaeans ***OR*** methanogens ✓	*Accept a **named** bacterium*	**1**
10.	b		continuous because there is a constant input of raw materials ✓		**1**
10.	c		a. pH/acidity/alkalinity ✓ b. foam ✓ c. metabolites ✓ d. substrate ✓ e. oxygen ✓ f. carbon dioxide ✓ g. temperature ✓ h. pressure ✓	*Accept other valid condition*	**3 max**
10.	d		methane ✓		**1**
10.	e		a. mixing substrate to increase contact with bacteria ***OR*** preventing sedimentation ✓ b. avoids formation of biofilms ✓ c. aeration for aerobic bacteria ✓		**2 max**

Question			Answers	Notes	Total
11.	a		a. by detecting a marker/resistance/sequencing gene ✓ b. the offspring produce yellow rice ✓	*Accept PCR to detect the marker gene.*	**1 max**
11.	b		a. biopharming is the introduction of genes into another species for medical use ✓ b. β-carotene/provitamin A is added to rice to prevent «night» blindness/diseases ✓ c. through genetic engineering ✓		**2 max**
11.	c		a. «Ti/tumour inducing» plasmid of *A. tumefaciens*/bacterium causes tumours/galls ✓ b. Ti incorporates genes «of β-carotene synthesis» ***OR*** Ti is used as a vector of the gene «for β-carotene» ✓ c. recombinant plasmids reintroduced into *A. tumefaciens*/bacterial cells ✓ d. bacteria infect rice plant cells ✓ e. the newly incorporated gene produces β-carotene/Golden Rice ✓		**3 max**
11.	d		*sequence shown on alignment:* Corn TESVYSAALALGIANQLTNILRDVGEDARRGRIYLPQDELA Daffodil AESVYNAALALGIANQLTNILRDVGEDARRGRIYLPQDELA **** ** Corn QAGLSDEDIFKGVVTNRWRNFMKRQIKRARMFFEEAERGVN Daffodil EAGLSDEDVFTGKVTDKWRSFMKRQIKRARTFFEQAEKGVT ******* * * ** ** ********** *** ** ** Corn ELSQASRWPVWASLLLYRQILDEIEANDYNNFTKRAYVGKG Daffodil ELSQASRWPVWASLLLYRQILDEIEANDYNNFTKRAYVSKV ** * Corn KKLLALPVAYGKSLLLPCSLRN---GQT Daffodil KRLAALPLAYGKSLLIPLSLRPPSLSKA * * *** ******* * ***		**1**

(continued…)

(Question 11 continued)

Question			Answers	Notes	Total
11.	**e**		a. BLASTp aligns amino acids «of proteins» ✓ b. BLASTn aligns nucleotides «of DNA/RNA» ✓ c. amino acid sequence is shown therefore BLASTn would not work ✓		**2**
11.	**f**		a. dashes are shown where there is no alignment ✓ b. due to lack of amino acids on one of the sequences ✓ c. in order to make them align the computer introduces gaps ✓ d. the sequence with dashes does not include the sequence of the other protein shown ✓		**3 max**

Question			Answers	Notes	Total
12.			a. blood/urine cultures to diagnose bacterial infections ✓ *ELISA*: b. «ELISA» uses antibodies specific to pathogen antigen ✓ c. the antibodies are linked to an enzyme ✓ d. after binding of the antibody enzyme complex samples are washed to remove unbound complex ✓ e. is added for the enzyme which changes colour «if they join with an antigen» ✓ *MICROARRAY*: f. test for specific mRNA sequences «using a microtiter plate» ✓ g. reverse transcriptase used to make cDNA from mRNA, linked with fluorescent dye ✓ h. «laser» light detects when cDNA and DNA hybridize which confirms presence of protein ✓ *PCR*: i. detection of genetic material from the pathogen is obtained using a PCR «by using primers based on pathogen sequences» ✓ j. if DNA/RNA is amplified «more than control» then infection is confirmed ✓ k. problems of false positive or false negative «in test result interpretation» ✓		**6 max**

Option C — Ecology and conservation

Question			Answers	Notes	Total
13.	**a**		Japanese stiltgrass ✓		**1**
13.	**b**		produce seeds which spread when cutting ***OR*** avoid vegetative proliferation/cloning ***OR*** may provide habitats for other species ✓	*Accept any other reasonable answer*	**1**
13.	**c**		a. «biotic» competition with native plants ***OR*** disrupt the food chain/ecosystem ✓ b. competition for abiotic factors ✓ c. reduce competitive exclusion ***OR*** avoid overlapping niches ✓ d. can cause changes to soil ✓ e. break/damage/cause death/extinction of native plants ✓	*Accept an example of an abiotic factor such as light/space/water/etc* *eg: Rhododendrons/conifers acidify the soil, making it difficult for other species to grow*	**2 max**
13.	**d**		a. «control» introduced species should only target alien plants ***OR*** «control» introduced species should not outcompete endemic species ✓ b. should not upset food chains/habitats ✓ c. should have some natural control/predator ✓ d. should not spread outside required area/not become invasive themselves ***OR*** field testing for effectiveness ✓	*OWTTE*	**2 max**

Question			Answers	Notes	Total
14.	a		there is exchange of matter/energy ***OR*** there is an exchange between the surface of the water and the atmosphere ✓	*eg: matter could be nutrients/gas/water/minerals/etc; energy could be heat or light*	**1**
14.	b		soil and no fish **«**mesocosm**»** ***AND*** soil and fish **«**mesocosm**»** ✓	*Both mesocosms required* *Accept answers such as "the two with soil".*	**1**
14.	c		a. zooplankton feed on bacteria reducing their numbers ✓ b. fish feed on zooplankton **«**therefore**»** increasing bacterial population ✓		**2**
14.	d		a. conditions closer to levels experienced naturally by the organism ✓ b. natural variation of abiotic variables ✓ c. more natural behaviour/interactions ✓ d. not harm organisms by removing them from natural habitat ✓	*OWTTE* *Accept examples, eg: temperature, dissolved oxygen*	**2 max**

Question			Answers	Notes	Total
15.	**a**		«group» I ✓		**1**
15.	**b**	**i**	number of individuals of a species ✓		**1**
15.	**b**	**ii**	tolerance rating of that species ✓		**1**
15.	**c**		a. group V organisms «could» contain indicator species ✓ b. group V organisms can survive in polluted environments «while others cannot» ✓ c. they have a high tolerance/BI index ***OR*** «relative number of» indicator species can be used to calculate the value of a biotic index ✓ d. the more group V present could indicate more pollution ✓ e. absence of group V could indicate a cleaner environment ✓	*OWTTE*	**3 max**

Question			Answers	Notes	Total
16.	a		a. phosphate-rich rocks/resource is limited ✓ b. demand exceeds availability of phosphorus ***OR*** there is greater consumption than P available ✓ c. cycling of phosphorus is slow ✓ d. as crops are removed, the phosphate levels within the soil is continually depleted ✓ e. there is no biological/industrial way to replenish the mineral «fast enough» ***OR*** «phosphate» fertilizers need to be added «to replenish it in the soil» ***OR*** «lost phosphate» does not go back in the cycle ✓	*OWTTE*	**3 max**
16.	b		a. <u>phosphates</u> are leached to lakes/rivers ✓ b. induces incremental growth of plants/bloom/algae ✓ c. algae do not let light go through water so less photosynthesis ✓ d. plants/algae die/decay ✓ e. bacterial decomposition consumes the oxygen ✓ f. creating state of hypoxia ***OR*** greater biochemical oxygen demand ✓ g. causing death of «aerobic» organisms ✓	*eg: fish*	**3 max**

Question			Answers	Notes	Total
17.				*This question can be answered by referring to one specific species*	**6 max**
			a. «keystone species» have a main/disproportionate role in the maintenance of the structure of a community ✓		
			b. not necessarily top predator/most abundant species ***OR*** affect other organisms even if they have a small biomass/productivity		
			c. may impact a top-down/bottom-up control ✓		
			d. «if removed» cause increase in populations of secondary consumers and decrease of primary consumers ✓	*OWTTE*	
			e. «if removed» may cause loss of balance in food chain/community ✓		
			f. «if removed» may cause «drastic» loss of biodiversity ***OR*** extinction of species ✓		
			g. example of named keystone species ✓	*eg: honey bees*	
			h. example of role in the environment where they are found ✓	*eg: pollinate flowers*	
			i. example of change if removed ✓	*eg: plant reproduction is reduced*	

Option D — Human physiology

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>18.</td><td>a</td><td></td><td>small intestine ✓</td><td></td><td>1</td></tr>
<tr><td>18.</td><td>b</td><td></td><td>a. hemoglobin «from red blood cells» broken down into heme and globin ✓
b. iron removed from heme ✓
c. «remainder of» heme group transformed to bilirubin ✓
d. «surplus» cholesterol is converted to bile salts ✓
e. bilirubin and bile salts form bile ✓</td><td></td><td>3 max</td></tr>
<tr><td>18.</td><td>c</td><td></td><td>a. use as energy source «for cellular respiration»
OR
«long term» energy storage ✓
b. fat tissue for «heat» insulation ✓
c. protects axons by myelin sheath
OR
other function of fats ✓</td><td>Accept first function written only</td><td>1 max</td></tr>
<tr><td>18.</td><td>d</td><td></td><td>a. microvilli/brush border to increase surface area ✓
b. numerous mitochondria for energy for active transport ✓
c. have transport proteins for specific nutrients ✓
d. single layer of cells/short distance allowing for diffusion ✓</td><td>Explanation must be included for each characteristic
eg: glucose, amino acids</td><td>2 max</td></tr>
<tr><td>18.</td><td>e</td><td></td><td>
<table>
<tr><th></th><th>Process</th><th>Fat</th><th>Glucose</th><th></th></tr>
<tr><td>a.</td><td>Transported in micelles</td><td>yes</td><td>no</td><td>✓</td></tr>
<tr><td>b.</td><td>Absorption mostly into lacteals</td><td>yes</td><td>no</td><td>✓</td></tr>
<tr><td>c.</td><td>Transported from gut in blood</td><td>no</td><td>yes</td><td>✓</td></tr>
</table>
</td><td>Award [1] for each correct row
Award the mark only for rows containing two correct answers, ie: no blanks accepted</td><td>3</td></tr>
</table>

Question			Answers	Notes	Total
19.	a		a. both males and females have higher «mean/range» SBP as weight increases ***OR*** both males and females have highest SBP for overweight BMI ✓ b. «SPB» males «slightly» greater than females in all BMIs ✓ c. similar values/no/little difference between underweight and normal weight in females but «visible/obvious» difference in males ✓ d. range of SBP narrower in «overweight» females than males ✓		**2 max**
19.	b	i	«at rest/chronic/constant» higher than normal «120 mmHg» systolic blood pressure is an indicator of hypertension ✓	*OWTTE*	**1**
19.	b	ii	stroke ✓ thrombosis ✓ blood clot ✓ heart attack ✓ heart failure ✓ aortic aneurysms ✓ coronary heart disease/CHD ✓ peripheral arterial disease ✓ atherosclerosis ✓	*Award up to **[2 max]** for the first two answers given*	**2 max**
19.	c		*blood pressure*: sphygmomanometer/blood pressure monitor ***OR*** description how this is used ✓ *heart rate*: taking pulse manually/using a blood rate monitor/stethoscope «to count the beats» ✓	 *OWTTE*	**2**

Question			Answers	Notes	Total
20.	**a**	**i**	breast ✓		**1**
20.	**a**	**ii**	FSH ✓		**1**
20.	**a**	**iii**	estrogen ***OR*** progesterone ✓		**1**
20.	**b**		a. growth and development of the breast/mammary gland ✓ b. lactation/synthesis of milk ✓ c. maintenance of milk secretion ✓		**2 max**
20.	**c**		a. oxytocin ✓ b. antidiuretic hormone/ADH/vasopressin ✓		**2**

21.			a. pH of blood is regulated to stay within a narrow range/7.35 to 7.45 ✓ b. increase in CO_2 produced during aerobic respiration «during exercise» ✓ c. CO_2 reacts with water to form carbonic acid ✓ d. chemoreceptors detect drop in blood pH «when CO_2 concentration rises» ***OR*** «increase in» CO_2 lowers blood pH ✓ e. carbonic acid dissociates to form hydrogen carbonate ions and hydrogen ions ✓ f. hydrogencarbonate is alkaline/increases pH/neutralizes H^+ ions ✓ g. hydrogen ions bind to plasma proteins/hemoglobin ✓ h. stimulation of breathing centre/medulla oblongata ***OR*** ventilation rate increased ✓ i. faster diffusion/removal of CO_2 «in alveoli/lungs» ✓	*If values provided, both required* *Allow formula* *OWTTE*	**6 max**