Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2020

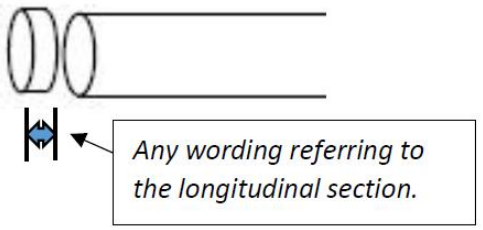
Biology

Higher level

Paper 3

20 pages

Section A

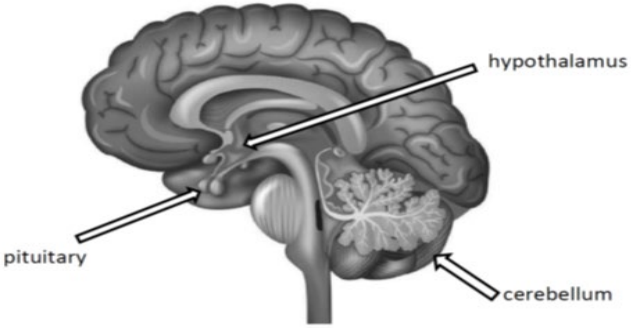
Question			Answers	Notes	Total
1.	a		*Calculation:* size of bar ÷ 15 μm (1.5 cm ÷ 15 μm or 15 000 μm ÷ 15 μm); *Answer*: 1000 x;	*First marking point is for division by 15 μm;* *Second marking point is for the correct answer; accept 930 and 1070 x.*	**2**
	b		(upper surface/epidermis usually has) fewer stomata/lower stomatal density/no stomata/OWTTE	*Do not accept a numerical value only.*	**1**
2.	a		*Independent*: mass; *Dependent*: (vertical) diameter;	*Do not accept elasticity.*	**2**
	b		a. width/depth of section/slice (of the ring); b. same animal/age/freshness/temperature;	*Do not accept thickness or diameter.* 	**1 max**
	c		a. veins have thinner walls (than arteries); b. veins sustain lower (blood) pressure (than arteries); c. when stretched, veins become longer (than arteries); d. veins have less muscle/elastic (fibre in their) walls (than arteries); e. veins have lower elasticity/recover less/remain more stretched (than arteries after weights removed);	*Accept inverse for arteries in all cases.* *Do not accept a listing of numerical values without explanation.*	**3 max**

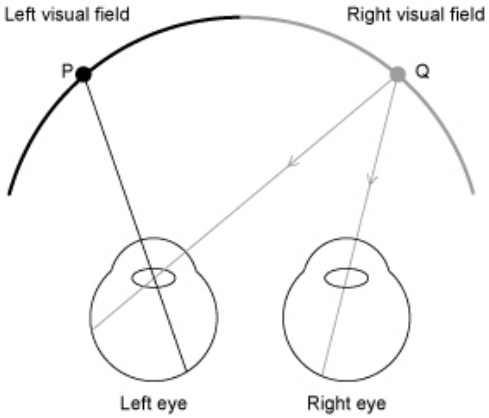
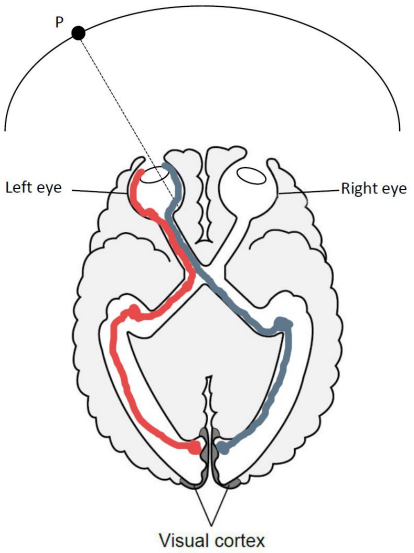
3.	**a**		photosynthesis/light independent reaction (of photosynthesis)		**1**
	b	**i**	the jars closer to the light had more purple colours ***OR*** the jar the furthest from the light was yellow ***OR*** purple to yellow	*Allow for answers indicating colours for each jar within this range.*	**1**
		ii	a. high light (intensity) increases photosynthesis; b. photosynthesis consumes CO_2; c. (more photosynthesis/less CO_2) increases pH/decreases acidity; d. less light means more respiration (than photosynthesis); e. respiration produces CO_2 ***AND*** lowers pH/increases acidity;	*Allow inverse for all answers.* *Do not accept reference to colour only instead of pH.*	**3 max**
	c		temperature/volume of indicator/identical jars/number of beads/size of beads / density of *Chlorella* / other reasonable answer	*Do not accept light/pH/humidity.*	**1**

Section B

Option A — Neurobiology and behaviour

Question			Answers	Notes	Total
4.	**a**		a. branches (of dendrites/axons) formed ***OR*** new/more dendrites formed; b. dendrites/axons grow/get longer;		**2**
	b		a. neural tube differentiation/formation; b. neuron (may) migrate to other parts; c. axon (may) extend beyond the neural tube/myelinates; d. synapses develop; e. neural pruning;	*Do not accept "connection" instead of "synapse".*	**2**
	c		a. neural pruning; b. neurons are destroyed / apoptosis		**1 max**

Question			Answers	Notes	Total
5.	**a**	**i**	label to cerebellum	*Diagram is for 5(a)(i), (b), (c)*  	**1**
		ii	controls/coordinates (motor) movements/balance		**1**
	b		label to pituitary ***OR*** label to hypothalamus;	*See 5ai for diagram.*	**1**
	c		*Alternative 1:* a. fMRI; b. scan detects changes in blood flow/oxygen in blood ***OR*** more active parts of brain receive more blood flow; *Alternative 2:* c. lesions/autopsy; d. part of the brain damaged ***OR*** loss of function detected; *Alternative 3:* e. stimulation during open brain surgery; f. reaction observed;	*The "f" must be written for fMRI.* *Description must relate to method named.*	**2 max**

Question			Answers	Notes	Total
6.	a		 any straight line from P passing through the lens to the retina of left eye		**1**
	b	**i**	visual cortex/occipital lobe		**1**
		ii	right	*See note in a.*	**1**
	c		ganglion (cell)		**1**

Q		Answers	Notes	Total
7.	**a**	a. (the pattern/unit is) a low frequency followed by higher frequency; b. the same pattern/unit is repeated; c. range limited to specific frequencies;		**2 max**
	b	a. early birdsong pattern is genetically determined/innate; b. later birdsong pattern is modified based on learning from adults/other birds;	*OWTTE*	**2**
8.	**a**	*Strengths:* a. (slight) increase in mate choice at higher male brightness index; *Weaknesses:* b. dots are scattered without a trend/no clear correlation ***OR*** most females choose mates around normal (brightness); c. insufficient data/information provided;	*Allow any other data-based statement.*	**2**
	b	a. natural selection favours specific types of mate selection/behaviour; b. (behaviour/mate selection) increases the chances of survival/reproduction; c. chosen organisms/males will leave more offspring; d. pass on gene(s) for behavior to offspring; e. (behaviour/allele) will become more prevalent/frequent in a population;		**3 max**
	c	<u>vampire</u> bats share blood to ensure survival;	*Other verified, outlined example.*	**1**
9.		a. psychoactive drugs act upon the central nervous system/alter brain function; b. psychoactive drugs are addictive; *Stimulants*: c. increase postsynaptic transmission; d. mimic the stimulation provided by the sympathetic nervous system ***OR*** mimic action of natural stimulating neurotransmitters e.g. acetylcholine; e. example: e.g. nicotine/cocaine/amphetamine; *Sedatives:* f. decrease postsynaptic transmission; g. mimic inhibition (of the parasympathetic nervous system) ***OR*** mimic action of natural inhibiting neurotransmitters e.g. dopamine; h. example: e.g. benzodiazepines/alcohol/tetrahydrocannabinol (THC);		**6 max**

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
10.	**a**	**i**	2		**1**
		ii	a. pH decreased by citric acid; b. (pH lowered by) production of CO_2 produced (by the fungus) in respiration; c. (pH lowered by) production of carbonic acid by CO_2 dissolving in water;		**2 max**
	b		batch fermentation because the citric acid is collected at the end of the fermentation ***OR*** batch fermentation because the process was carried out over 6 days then re-set up ***OR*** diagram does not show constant supply of nutrients so it must be a batch;		**1**
	c		preservative/flavour	*Accept other verified use, e.g. buffering.*	**1**
11.	**a**		2006		**1**
	b		a. glyphosate use increased and other herbicides use decreased; b. during this period there was no increase/decrease in the EIQ ***OR*** the data shows that there was not much change in environmental impact; c. data insufficient to reach conclusion;	*Both must be mentioned for the mark.*	**2**

(Continued…)

(Question 11 continued)

Question			Answers	Notes	Total
	c		a. the bacterium inserts a plasmid into plant cells; b. the Ti plasmid induces tumours in plants; c. (Ti plasmid) modified to include a gene coding for glyphosate resistance; d. (Ti plasmid) integrates its DNA into the plant genome ***OR*** plasmid is used as a vector to introduce glyphosate resistance gene; e. tumour/gall tissue is cultured to form plants with the gene for glyphosate resistance;		**3 max**
12.	**a**		a. biofilm bacteria are all together while free bacteria do not interact with others; b. biofilm bacteria present emergent properties not present in free bacteria; c. quorum sensing only found in biofilm; d. EPS matrix only in biofilm; e. biofilm bacteria are more resistant to antibiotics/disinfectants;		**3 max**
	b		*Monochloramine not a good choice* ***[1 max]*** a. high concentrations/amounts are needed; b. health risks need to be assessed; *Monochloramine a good choice* ***[1 max]*** c. monochloramine is more stable; d. monochloramine range for biofilm is very extensive OR some biofilm bacteria must be highly resistant;		**2 max**
	c		viruses/(bacterio)phages that are specific to the bacterium are used to kill it;		**1**

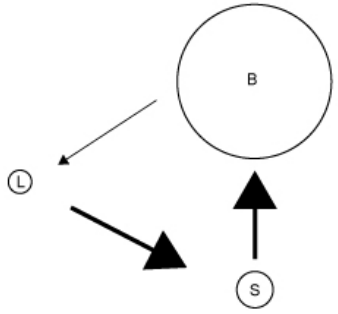
Question			Answers	Notes	Total
13.	**a**		a. fusion between genes of (viral) capsid and hepatitis B antigen/HBsAg; b. (transformed) virus infects tobacco plant; c. tobacco plant expresses antigen/HBsAg; d. HBsAg producing plants fed to animals; e. animals produce anti-HBsAg antibodies;		**3 max**
	b		as time passes, the soybean produces less antigen / stabilizes to a lower level (after 6 months)		**1**
	c		DNA/nucleotide sequence with a start codon and stop codon coding for a polypeptide chain;		**1**
	d		a. gene databank; (e.g. GenBank/NCBI); b. BLASTn to search similar DNA sequences; c. ORF finder to search for the start codon; *Alternative:* d. protein database search for antigen (sequence); e. example of database; (e.g. NCBI/SwissPro/Uniprot/PDB/other checked database); f. BLASTp to search similar protein sequences;		**2 max**

Question			Answers	Notes	Total
14.			*Presence of genetic material (PCR and/or microarray)*: [*Allow **4 max***] *PCR:* a. presence of the genetic material can be amplified by PCR; b. if the genetic material is RNA, a reverse transcription PCR must be performed ***OR*** using reverse transcriptase, the enzyme must first transform RNA into DNA; c. PCR primers stick to DNA; d. amplify DNA; *Microarray:* e. genetic material can be detected in microarray; f. probes of the DNA of the pathogen are placed on the chip; g. if the pathogen DNA is complementary, there is fluorescence; *Presence of proteins:* [*Allow **4 max***] h. presence of the proteins can be detected by ELISA; i. the test detects the antigens which are proteins of the pathogens; j. it uses antibodies stuck to a plate (which capture the pathogen antigen) ***OR*** it detects antibodies against pathogen; k. antibodies with an enzyme/fluorescence are used to reveal binding; l. metabolites of the disease detected in blood/urine;		**6 max**

Option C — Ecology and conservation

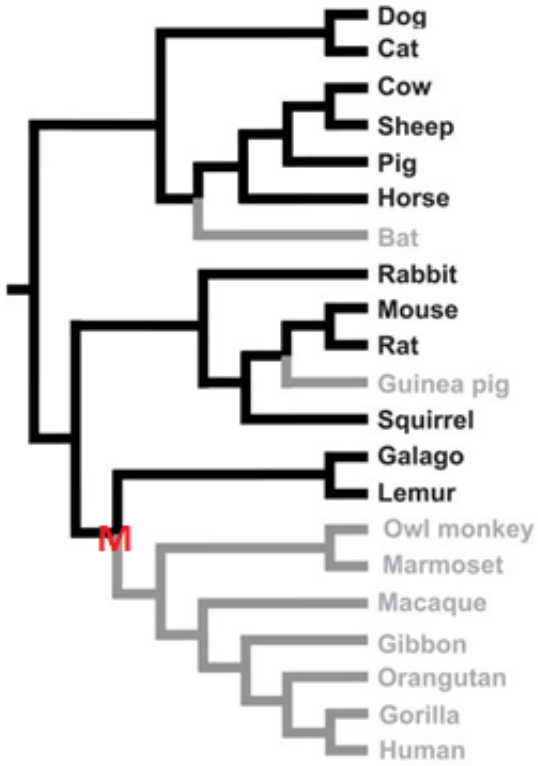
Question			Answers	Notes	Total
15.	**a**		a. with quadrats (of 0.5 m side / 0.25m^2); b. (quadrats) position determined at fixed distance by transects ***OR*** (quadrats) position determined at random; c. random sampling / capture-recapture; d. average number calculated;		**2 max**
	b		a. sea otters (feeding on sea urchins) limit sea urchin population; b. the largest sea urchins are eaten; c. shown by low biomass/small size (of sea urchins); d. fewer/smaller sea urchins allow for increase in algae population; e. sea otters have a top down effect;	*Allow converse reasoning.*	**3 max**
	c		the sea urchins' limiting factors in their original habitat are missing ***OR*** lack of (natural) predators for sea urchins		**1**

Question			Answers	Notes	Total
16.	**a**	**i**	2		**1**
		ii	a. birds are unable to fly/swim for food; b. unable to escape predators; c. birds drown; d. birds suffocate/are strangled;		**1 max**
	b	**i**	(group) C / albatrosses, petrels and shearwaters		**1**
		ii	a. fill up the stomachs (of young birds) so they feel full / starve to death; b. damage the digestive system / cut the gut/stomach/oesophagus/intestines (leading to internal bleeding); c. block passage of food (causing starvation); d. cause choking (so cannot breathe); e. contain/decompose to microplastics/toxic chemicals (poisoning birds) ***OR*** toxins/microplastics in seawater build up/biomagnify (and poison wildlife);		**2 max**

Question			Answers	Notes	Total
17.	a		a. richness refers to the number of (different) species in the environment/community/ecosystem; b. evenness refers to the number of individuals within each species; c. richness and evenness are components of biodiversity; d. biodiversity measured by (Simpson's) diversity index;	*Accept converse.* *Do not accept "species" to mean "individuals of a species".*	**2 max**
	b		temperature; precipitation; pH/e.g. acid rain; tides; sunlight; substrate; minerals/nutrients; pollutants;	*Only mark the first two factors if more than two are stated.* *Allow any other verified factor.*	**2 max**
	c		a. breeding/migration changes the number of individuals of some species; b. variation in some abiotic factors; c. food availability;	*Accept any reasonable suggestion that could cause a variation of number of individuals of some species reducing evenness.*	**1 max**
	d		*Gersmehl diagram showing the following:* a. thick arrow from soil to biomass: b. thick arrow from litter to soil; c. thin arrow from biomass to litter;		**3**

Question			Answers	Notes	Total
18.	**a**		a. between 1930 and 1968 the numbers were reduced; b. after 1968/in the 1970s the numbers increased; c. in 1990s1995 the numbers decreased again; d. lowest in 1968 and highest in 1990;		**3 max**
	b		a. relative rates of natality; b. disease/lack of food; c. competition for the same resources; d. immigration/emigration/migration;		**2 max**
19.			a. excess rains/floods/irrigation can wash away nutrients/N/P by leaching; b. excess rains/floods/irrigation can lead to waterlogged soils; c. waterlogging leads to denitrification due to anaerobic conditions; d. nutrients are added to the cycles by application of fertilizer; e. nutrients are removed by the harvesting of agricultural crops; *Nitrogen:* f. lightning increases N in soil; g. planting legumes increases N in soil; *Phosphate:* h. mining of P speeds up the P cycle/depletes P reserves; i. phosphorus is added to waters in detergents; j. phosphorus is mined/taken from rocks for making detergents/fertilizers;		**6 max**

Option D — Human physiology

Question			Answers	Notes	Total
20.	a				1
	b		cannot be synthesized by the body		1
	c		250 (mL)		1

Question			Answers	Notes	Total
21.	**a**		a. produces acid to break down molecules; b. churns food for mechanical digestion; c. produces proteases to digest proteins/peptides;	*Allow pepsin.* *Do not allow "acid kills bacteria".*	**2 max**
	b		production of <u>hydrochloric acid</u>/<u>HCl</u>		**1**
	c	**i**	*Helicobacter pylori*/*H. pylori*		**1**
		ii	a. acidity is achieved by a proton pump/H^+, K^+-ATPase; b. exchange of H^+ from the cytoplasm for K^+ ions in the lumen; c. PPIs bind irreversibly to the (proton) pump; d. lowering amount of acid produced/H^+;		**3 max**
22.	**a**		a. systolic pressure increases with salt in diet during treatment; b. diastolic pressure is slightly higher/no change with salt during treatment ***OR*** diastolic pressure only changes towards the end of the period; c. (blood) pressure goes back to normal after treatment ***OR*** salt causes increased (blood) pressure; d. standard deviation values overlap therefore not statistically significant;		**2 max**
	b		sphygmomanometer/blood pressure <u>monitor</u>;		**1**
	c		a. sinoatrial node/SAN initiates contraction of atria; b. SAN sends messages to the atrioventricular/AV node; c. AV node initiates ventricular contraction; d. through conducting fibres;		**2 max**

Question			Answers	Notes	Total
23.	**a**		a. respiring tissues produce CO_2; b. CO_2 leads to an increase in H+/decrease in blood pH; c. increased acidity/decreased pH shifts the oxygen dissociation curve to the right; d. affinity of the hemoglobin for oxygen is reduced; e. greater release of oxygen from hemoglobin (at the same partial pressure of oxygen) in tissues;		**3 max**
	b		a. dissolved/carried in plasma; b. forms carbonic acid/H_2CO_3 (in plasma) ***OR*** as hydrogencarbonate (HCO_3^-) ions (in plasma); c. binds to hemoglobin in red blood cells;		**2 max**
	c		increased carbon dioxide in blood increases the rate of ventilation ***OR*** positive correlation/relationship;		**1**
	d		a. hemoglobin (from broken red blood cells) taken up by Kupffer cells (in the liver); b. hemoglobin broken down into heme and globin; c. globin hydrolyzed/broken down to amino acids; d. iron removed from heme group ***OR*** heme broken down to form bilirubin/bile pigment;	*Do not accept red blood cells broken down into heme and globin.*	**3 max**

Question			Answers	Notes	Total
24.			a. endocrine glands secrete hormones directly into the bloodstream; *Steroid hormones*: b. pass through the plasma membrane (of target cells); c. bind to receptor proteins in the cytoplasm ***OR*** form a receptor–hormone complex; d. (receptor–hormone complex) enters the nucleus; e. promotes the transcription of specific genes; *Peptide hormones:* f. bind to receptors in the plasma membrane (of the target cell); g. (binding of hormones to membrane receptors) activates a cascade of reactions; h. (cascade of reactions) mediated by a second messenger (inside the cell); i. (cascade results in) activation of enzymes;		**6 max**