Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2017

Biology

Higher level

Paper 3

26 pages

Section A

Question			Answers	Notes	Total
1.	a	i	spirometer ***OR*** lung volume capacity bag/balloon ***OR*** chest belt ***OR*** pressure meter ✓	*Do not accept respirometer*	**1**
	a	ii	a. set to zero mark / «re»calibrate ✓ b. sit up straight or stand up/same position ✓ c. inspire/inhale as deeply as possible «through mouthpiece» expire/exhale as completely as possible ✓ d. several times ✓ e. Detail specific to apparatus such as displacement of water when using a balloon ✓		**2 max**
	b		a. «useful as» will increase FVC «over time» ✓ b. «not useful as» no effect on FEV «is similar to control / small increase» ✓ c. consequence not clear «maybe only runners with higher FVC succeed to professional level» ✓		**1 max**
	c		age / sex / health / height / mass ✓	*Do not accept BMI*	**1 max**

Question			Answers	Notes	Total
2.	**a**		× 50 ✓	*Accept range × 45 to × 50* *Calculation not required.*	**1**
	b		a. place the object on the stage «centred» below the objective lens/above the light ✓ b. focus by moving the objective lens and specimen apart rather than towards each other ✓ c. use coarse/large focusing first/to find areas of interest and then fine/small focusing «knob» ✓ d. use low power first/to find areas of interest ***OR*** use high power to look in detail ✓ e. adjust light intensity ✓		**3 max**
	c		living tissue can be observed / portable / cheaper / easier to use / possibility of observing movements / image is in colour / larger field of view can be observed ✓		**1 max**

Question			Answers	Notes	Total
3.	**a**		a. decrease in chlorophyll concentrations as decrease in phytoplankton/plants ✓ b. due to increase in pollution / increase in sea temperatures / decrease in pH/climate change ✓	*Accept other reasonable reason for mp b.*	**2 max**
	b		*Advantages of mesocosm experiments:* a. scientist can alter/manipulate/control environmental conditions ✓ b. allows carrying out experiments with many samples / replicates ✓ c. ease of collection of continuous data ✓ *Limitations of mesocosm experiments:* d. difficult to mimic natural environmental conditions exactly ✓ e. Natural environments change /are not static ✓	*Needs to suggest advantage and limitation for full marks.*	**3 max**

Section B

Option A — Neurobiology and behaviour

Question			Answers	Notes	Total
4.	**a**		a. positive correlation «between grey matter volume and white matter volume» ***OR*** as white matter «volume» increases so does grey matter «volume» ✓ b. as animal/brain size increase the volume of grey and white matter are «approaching» equal ***OR*** as volume of grey matter increases, the ratio grey : white becomes closer to 1 ✓	*Do not allow directly proportional.* *Accept answers in the converse.*	**1 max**
	b		a. axon grows from an «immature» neuron ✓ b. chemical stimuli trigger the growth/direction of axon ✓ c. only one axon develops per neuron ✓ d. some axons extend beyond neural tube to reach other parts of body ✓		**2 max**
	c		*Structure* a. divided into left and right hemisphere ✓ b. has extensive folding ✓ c. has a large surface area : volume ratio ✓ *Function* d. responsible for higher order functions/learning/memory/language/thinking ✓ e. functions are located in specific areas of the cortex/lobes ✓ f. sensory/motor functions of the left hemisphere correspond to the right side of the body ✓	*To achieve full marks needs to mention one structure and one function.*	**3 max**

Question			Answers	Notes	Total
	d		a. «brain» cells/neurons carry out large amount of respiration/metabolic activity ✓ b. maintenance of resting potential requires energy/ATP ***OR*** functioning of Na-K pumps requires energy/ATP ***OR*** nerve impulse requires energy/ATP ✓		**1 max**
	e		gut muscles / heart rate/cardiac centre / vasomotor / breathing/ventilation rate / reflex centre of vomiting/coughing/sneezing/swallowing ✓		**1 max**
5.	**a**		a. microphone outside the ear pick up sounds ✓ b. sound waves converted to electronic/digital signals ✓ c. electronic impulses sent to electrode in cochlea ✓ d. «electrode» directly stimulates auditory nerve ✓ e. signals «generated by implant» sent to brain which recognizes signals as sound ✓		**3 max**
	b		semicircular canals		**1**
	c		a. transmit the signals from the photoreceptors «rods and cones» to the ganglion cells ✓ b. groups of/more than one rod cell synapse with one bipolar cell ✓ c. one cone cell synapses with one bipolar cell ✓ d. once light is absorbed bipolar cell depolarizes ✓ e. activates/depolarizes a ganglion cell ✓		**3 max**

Question			Answers	Notes	Total
6.	**a**		a. jumping performance shows an improvement «during the first two/three weeks» ***OR*** no/little improvement as error bars all overlap ✓ b. «during the period of this investigation» it reaches a plateau ✓ c. the investigation was over a short time and is not conclusive of the effects of training over a longer period ✓		**2 max**
	b		a. sensory/afferent neuron ✓ b. motor/efferent neuron ✓ c. relay neuron/interneuron ✓	*Two correct for **[1]*** *Three correct for **[2]***	**2 max**
	c		a. operant conditioning/classical conditioning/trial and error experiences ✓ b. behaviour could be modified by positive/negative reinforcement ✓ c. animal makes an association between a particular behaviour and a consequence ✓	*Accept reward/punishment and/or examples such as food/electric shock.*	**2 max**
	d		a. innate behaviour inherited/develops independently of environment ***OR*** Changes in innate behaviour depend on change in frequency of alleles that cause the behaviour ✓ b. example of an innate behaviour ✓ c. description of the behaviour ✓ d. outcomes affecting survival ✓	*eg* *b. synchronized oestrus in female lions* *c. female lions can share responsibilities / females can suckle each other's cubs allowing some mothers to hunt* *d. cubs are more likely to survive when they are raised in a group «nursery» rather than by a solitary mother / group of male cubs can leave pride together helping each other*	**3 max**

Question			Answers	Notes	Total
7.			a. examples are benzodiazepines / THC / cannabis / alcohol ✓ b. block / decrease synaptic transmission ✓ c. causing less transfer of information to the brain / decreasing brain activity ✓ d. benzodiazepines increase effect of GABA ✓ e. GABA is an inhibitory neurotransmitter ✓ f. Increase permeability of neural membrane to chloride ions/hyperpolarizes the neuron ✓ g. alcohol enhances effect of GABA ✓ h. «alcohol» also decreases activity of glutamate, an excitatory neurotransmitter ✓ i. THC/cannabis can block cannabinoid receptors ✓ j. «THC» inhibits release of neurotransmitters that excite postsynaptic neurons/membranes ✓ k. use of psychoactive drugs can lead to dependence/addiction / alter dopamine levels ✓		**6 max**

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
8.	**a**	**i**	lack of oxygen/anoxic/anaerobic conditions / acidic pH / warm temperature / methanogens / acidogenic bacteria ✓	*Mark first answer given* *Reject bacteria alone*	**1 max**
		ii	a. increased variety of substrates used ✓ b. change in the proportion of substrates used ***OR*** from 1997 to 2004 increase in slaughterhouse waste ✓ c. less reliance on manure/increase use from food industry ✓ d. waste from food industry results in higher biogas yield ✓		**2 max**
	b		a. microbial population can be maintained in a state of exponential growth for a long time ***OR*** concentration of microorganisms in fermenter stable ✓ b. «balanced growth is» maintained by keeping nutrients/medium/pH/ temperature/oxygen level constant ✓ c. nutrients are added <u>and</u> products removed «at steady rate» ✓ d. probes used to monitor conditions within fermenters ✓ e. open fermentation/fermenter ✓		**3 max**
	c		a. Gram-negative bacteria have a thinner peptidoglycan cell wall / Gram-positive bacteria have a thicker peptidoglycan cell wall ✓ b. Gram-negative bacteria have an additional membrane of «lipopolysaccharide and protein» outside the wall «whereas Gram-positive bacteria do not» ✓		**1 max**

Question			Answers	Notes	Total
9.	**a**		a. identify a start codon and stop codon ✓ b. identify base sequences for a gene/that could code for a polypeptide ✓ c. possible correlation with existing open reading frames in databases ✓		**2 max**
	b		a. represent common ancestors shared by the organisms that emanate from the point ✓ b. indicates time since divergence ✓ c. indicates number of differences in DNA ✓		**1 max**
	c		a. plant cells made into protoplasts by removing their cell wall / use cellulase to produce protoplasts ✓ b. physical methods such as electroporation /microinjection/biolistics ✓ c. chemical methods such as liposomes/calcium chloride/polyethylene glycol «PEG» ✓ d. vectors such as *Agrobacterium*/tobacco mosaic virus ✓		**2 max**

Question			Answers	Notes	Total
10.	**a**	**i**	cooling- or heating-water systems / rocks at the bottom of a river / teeth «of most animals» / prepared on sewage treatment plants / boat hulls / medical catheters ✓	*Accept other verified examples*	**1 max**
		ii	a. have «new» properties that are not present in the individual microorganisms ✓ b. organisms form a matrix «EPS» / biofilms have a complex architecture ✓ c. increased resistance to antibiotics/treatments ***OR*** bioluminescence ✓ d. biofilms can be formed by different types of micro organisms that interact/cooperate ✓ e. quorum sensing ***OR*** high population/cell density determines expression of genes ✓		**3 max**

Question			Answers	Notes	Total
11.	**a**	**i**	A gene/DNA sequence «with a known location on chromosome» used for identification ✓		**1 max**
		ii	a. to identify species/pathogenic organisms ***OR*** successful uptake of DNA in genetically modified organisms/GMOs ✓ b. to detect disease due to variation in DNA «substitution/deletion» ✓ c. to determine risk of developing certain disorders ✓ d. to confer resistance to antibiotic/agent that would normally kill it ✓ e. to make cells containing gene look different ***OR*** green fluorescent tag makes cells visible under UV light ✓		**2 max**
	b		a. gene therapy trials have used viruses to deliver un-mutated copies of genes to the «somatic» cells of the patient's body ✓ b. examples of the use of viral vectors ✓ *eg gene therapy may provide a way to cure genetic disorders, such as severe combined immunodeficiency* c. one of the main problems is immune response to viruses / may cause toxicity/disease ✓ d. some viral vectors insert their genomes at a random location on one of the host chromosomes «which can disturb the function of cellular gene» / enter wrong cells «if targeting tumour» / could lead to cancer ✓		**2 max**

Question			Answers	Notes	Total
11.	**c**		a. analyze tissue/blood sample for DNA sequence ✓ b. each spot «on microarray» has small quantity of specific DNA sequence/ probe ✓ c. reverse transcriptase used to make cDNA ✓ d. fluorescent dye linked to cDNA ✓ e. «cDNA» binds to/hybridizes with probes that have complementary base sequences ✓ f. fluorescence/different colours shows probes have hybridized / which sequences were in the tissue sample ✓	*Allow specific examples of genetic diseases.*	**3 max**

Question			Answers	Notes	Total
12.			*Process* **(max [5])**: a. BLAST «Basic Local Alignment Search Tool» search enables comparison of an unknown sequence with databases of sequences ✓ b. «software» finds similar sequences / aligns sequences by locating matches between two sequences ✓ c. carries out statistical calculations «to find matches with other sequences» ✓ d. BLASTn used to align/show similarities in nucleotide sequences in nucleic acids ✓ e. BLASTp used to align/show similarities in amino acid sequences in proteins ✓ f. used to identify the gene of a protein ✓ *Application* **(max [2])**: g. one application of BLAST ✓ h. second application of BLAST; ✓	*eg* BLAST can be used for identifying species / locating domains / establishing phylogeny / DNA mapping / other verifiable examples	**6 max**

Option C — Ecology and conservation

Question			Answers	Notes	Total
13.	**a**		a. higher frequency of medium length worms ✓ b. shows normal distribution ✓ c. lower frequency at extremes ✓	*Allow correct numerical description of these points.*	**1 max**
	b		secondary consumer / third trophic level ✓		**1**
	c		a. in parasitism only one organism benefits whereas in mutualism both benefit ✓ b. example for both parasitism ***AND*** mutualism ✓	*Do not allow B. italica or B. exodonta as examples.* *eg parasitic: human tapeworms* ***AND*** *mutualism: bacteria in human digestive tract*	**2 max**

Question			Answers	Notes	Total
14.	**a**		a. increased biomass «with higher temperatures» ✓ b. «so» increased uptake of nutrients from soil «into the biomass» ✓ c. increased decomposition of litter «due to growth of decomposers» ✓ d. «so» increased nutrient composition of soil «L→ S» ✓ e. increased weathering of rocks «increasing minerals in soil» ✓ f. weather changes cause increased runoff from litter/leaching from soil ✓		**2 max**
	b		organism that is present/absent when specific environmental conditions exist ***OR*** organism used to assess a specific environmental condition ✓		**1**
	c		a. example ✓ *eg*: DDT / mercury / cadmium b. substance accumulates in «fat» tissue/not excreted «when consumed» ✓ c. contaminated organisms consumed «in large quantities» by higher level consumers ✓ d. pollutant becomes more concentrated at each higher trophic level / through the food chain ✓ e. some pollutants are more likely to be biomagnified «accumulate in fat tissue» **OR** some organisms are more likely to be affected by biomagnification than others **OR** biomagnification not the same at each trophic level ✓	*Only **[2]** if verified example not given.*	**3 max**

Question			Answers	Notes	Total
14.	**d**		a. uncontrolled increase of numbers «in alien species» ***OR*** become invasive ***OR*** have no «natural» predators ✓ b. outcompetes native species / reduces biodiversity ***OR*** carries disease ***OR*** preys on local species decreasing population size ***OR*** disrupts food chains/webs ✓		**2 max**
	e		closed because islands do not exchange matter/nutrients with surroundings ***OR*** open because islands do exchange matter/nutrients with surroundings ✓		**1 max**

Question			Answers	Notes	Total
15.	**a**		a. «not very successful as» less than half of the artificial inseminations have resulted in live births ✓ b. there are no data for artificial insemination that did not result in pregnancy / no data for normal breeding success «in zoos» ✓	*Accept answers in the converse: «not very successful as» more than half do not result in live births*	**1 max**
	b		a. raise awareness / gain widespread public/political support for conservation actions ✓ b. breed endangered species in captivity «for reintroduction» ✓ c. education/research opportunities ✓ d. lower maintenance/cost than *in situ* conservation ✓ e. protect endangered species ✓		**2 max**
	c		a. number of organisms of each species «present» ✓ b. «total» number of species ***OR*** «total» number of organisms of all species found ✓		**2 max**

Question			Answers	Notes	Total
16.	a		a. production of fertilizers will decrease/price of fertilizers will rise ✓ b. less food production / increase in cost of foods ✓ c. development of alternative methods of agriculture ✓ d. Phosphate needed by living organisms for nucleic acids/ATP so lack will affect growth negatively ✓		**2 max**
	b		a. largest store of phosphorus «in ecosystems» is in marine sediments and minerals/phosphate rock while nitrogen is in the atmosphere ✓ b. main source of release of phosphorous is by weathering of rocks «very slow process»/ nitrogen is by bacterial action ✓ c. high concentrations of nitrogen/low concentration of phosphorous «compounds» in living organism ✓ d. phosphorus is not a very soluble mineral ✓		**2 max**
	c		a. assimilation by plants / conversion to amino acids ✓ b. denitrification to nitrogen gas / reduction to nitrogen «N_2» by denitrifying bacteria ✓ c. reduction of nitrates to nitrites ✓		**2 max**

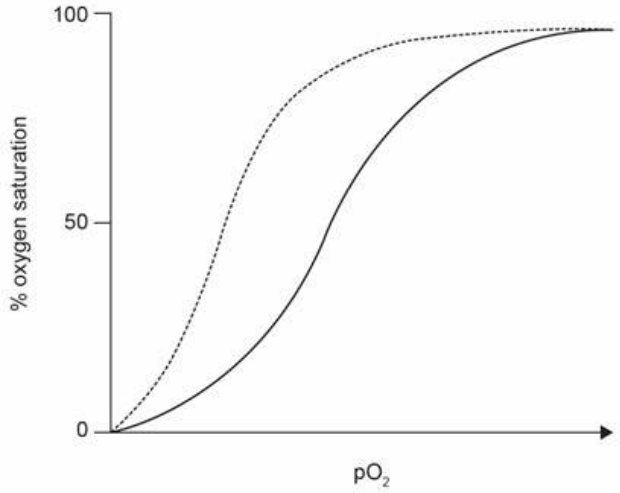
Question			Answers	Notes	Total
17.			a. exponential growth occurs in ideal/unlimited environment ✓ b. population growth determined by natality, mortality, immigration and emigration ✓ c. natality / births / reproduction increases population ***OR*** number of reproducing individuals determine the rate of growth ✓ d. as long as natality is higher than mortality ✓ e. low mortality leads to exponential growth ✓ f. absence of <u>limiting factors</u> will lead to exponential growth ✓ g. «limiting factors» could be «competition for» resources/habitat / presence of predators/diseases ✓ h. higher mortality and/or emigration compared to natality and/or immigration cause population to decrease/rate of growth to slow ✓ i. graph with exponential curve/exponential part of sigmoid curve labelled ✓	*Allow annotations on a sigmoid population graph.*	**6 max**

Option D — Human physiology

Question			Answers	Notes	Total
18.	**a**	**i**	infants from mothers with low levels of vitamin D have an increased chance of developing seizures ✓	*Accept answers in the converse*	**1**
		ii	lack of vitamin D in breast milk ***OR*** lack of vitamin D leads to lack of bone mineralization/calcium uptake ✓	*"Lack of vitamin D" alone is not sufficient*	**1**
	b		it can be synthesized by humans «in skin» ✓		**1**
	c		a. they cannot be synthesized by humans ✓ b. they must be present in the diet ✓		**1 max**
	d		a. tight junctions ✓ b. protein channels / membrane pumps ✓ c. large number of mitochondria ✓		**1 max**

Question			Answers	Notes	Total
19.	**a**		a. CHD has wider range/spread/more variation of diameter values / *vice versa* ✓ b. control has higher percentage/proportion/peak in middle values (*accept numbers between 8–12*) ✓	*Accept numerical statement supporting this*	**1 max**
	b		a. are branched/ have a Y-shape/ interconnected / connect to several neighbouring «cardiac» cells ✓ b. intercalated discs are special regions of/junctions between plasma membranes ✓ c. provide electrical coupling / enable rapid transmission of «electrical» impulses «between cells» ✓ d. ion channels in membranes ✓ e. «ease of» flow of ions allows action potentials to spread «between cardiac cells» ***OR*** «ease of» flow of ions allows rhythmic depolarization ✓ f. trigger action potentials without nervous input ✓	*Accept annotated drawings.*	**3 max**
	c		a. impulses from atria do not pass directly to ventricles «due to layer of fibrous material» ✓ b. travel to ventricle via atrio-ventricular node/AVN in wall of right atrium ✓ c. impulses from AVN sent along Bundle of His /conducting fibres/Purkinje fibres ✓ d. ensures that the atria have ejected their blood into the ventricles first before the ventricles contract ✓		**2 max**

Question			Answers	Notes	Total
20.	**a**		a. the more milk taken in, the higher the iodine levels ✓ b. when no milk consumed all girls «in study» were iodine deficient ✓ c. in all cases median value is mildly deficient so milk may have no effect ✓ d. increase above 1 cup/day may have no/little effect ✓	*Accept answers in the converse.*	**2 max**
	b		a. iodine is absorbed/used/needed by the thyroid ✓ b. «needed» to synthesise thyroxin ✓ c. lack of iodine causes swelling of thyroid gland/goiter/hypothyroidism ***OR*** thyroxin used to regulate metabolic rate/generate heat ✓		**2 max**
	c		a. «peptide hormones» do not enter cells ✓ b. bind to «specific surface» receptors in plasma membrane ✓ c. leads to production /release of a secondary messenger inside cell ✓ d. triggers a cascade of reactions in the cytoplasm ✓ e. usually involves activating or inhibiting enzymes ✓		**3 max**

Question			Answers	Notes	Total
21.	a	i	a. air sacs/alveoli break down/rupture ✓ b. creating one larger air space instead of many small ones / reduces the surface area of the lungs ✓ c. loss of elasticity of lung tissue ✓		**2 max**
		ii	supplemental oxygen / breathing techniques / bronchodilators / inhaled steroids / lung surgery to remove damaged tissue / lung transplant ✓		**1 max**
	b	i	curve has to be towards the right and starting together ✓  	*Must start together but can finish slightly below the original curve.*	**1**

Question			Answers	Notes	Total
21.	**b**	**ii**	a. increased levels of CO_2 lower the pH of the blood ✓ b. «which results in» decreased affinity of the hemoglobin for oxygen / greater release of oxygen ✓ c. this shifts the oxygen dissociation curve to the right/Bohr shift ✓		**2 max**

22.			a. erythrocytes rupture when they reach the end of their life span / after 120 days ✓ b. «erythrocytes» absorbed by phagocytosis ✓ c. Kupffer cells ingest/take in erythrocytes ✓ d. Kupffer cells in sinusoids in the liver ✓ e. hemoglobin split into globin and heme groups ✓ f. amino acids from the globin are recycled ✓ g. heme group is further broken down into iron and bilirubin / bile pigment ✓ h. iron stored in liver / transported to bone marrow/spleen ✓ i. bilirubin released into alimentary canal/becomes part of bile ✓		**6 max**