Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2019

Biology

Higher level

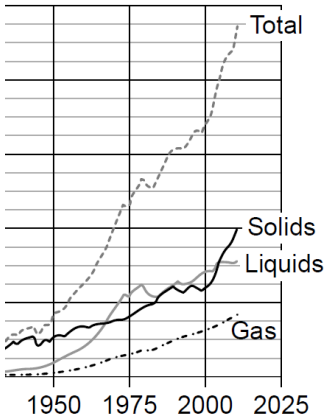
Paper 3

26 pages

Section A

Question			Answers	Notes	Total
1.	a		*Angiospermophyta*/Angiosperms ***AND*** flowers «as reproductive organs» ✓	*Both required.*	**1 max**
1.	b	i	ovule ✓		**1**
1.	b	ii	a. mutualistic relationship ***OR*** bee gets nectar/pollen «as food» ***AND*** flower is pollinated/fertilized ✓ b. when bee enters, pollen from anther sticks to it ✓ c. pollen is picked up by stigma «of same or other flower» ✓	*Both needed.*	**2 max**
1.	c		a. different values for the named independent variable ✓ b. large / equal number of seeds in each Petri dish ✓ c. control of other variables «than seeds» ✓ d. mentions how germination will be determined ***OR*** how germination rate/percentage will be measured ✓ e. includes a control giving seeds all factors needed ✓	*Possible factors include water, oxygen, temperature, pH, light, salt concentration.* *Name of the independent variable must be included, eg temperature.* *eg appearance of radicle.* *eg number germinated over time/in a set time.* *Do not accept measurement of growth of stem/number of leaves.*	**3 max**

Question			Answers	Notes	Total
2.	a		age/height/fitness level/weight/room temperature/rest in between tests/model or type of bike ✓	*Other valid factor. Only mark first factor listed.* *Do not accept sex, health, smoking, oxygen level or altitude as this already listed.*	1
2.	b		a. in both sea level and 4000 m ventilation rate while exercising «at all intensities» is «significantly» more than at rest ***OR*** both sea level and 4000 m show an increase in ventilation rate «dm^3 min^{-1}» as exercise intensity increased ✓ b. ventilation rate at 4000 m «slightly» higher than at sea level for all conditions ***OR*** higher ventilation rate at 4000 m not «significantly» different as error bars overlap ✓	*Accept positive correlation.*	2 max
2.	c		a. «data logging» with spirometer ***OR*** chest belt ✓ b. «tidal» volume recorded for a given period of time ***OR*** average «tidal» volume found and multiplied by number breaths per minute ✓	*Must include a reference to time.*	2

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>3.</td><td>a</td><td></td><td>«$\frac{(2250-300)\times 100}{300}$ =» 650 «%» ✓</td><td></td><td>1</td></tr>
<tr><td>3.</td><td>b</td><td></td><td>
<table>
<tr><th></th><th></th><th>Gas</th><th>Liquid</th><th>Solid</th></tr>
<tr><td>a.</td><td>similarity/ comparison</td><td colspan="3">all 3 increase use «over this period»
OR
gas and solid use increases in a similar/gradual way ✓</td></tr>
<tr><td>b.</td><td>difference/ contrast</td><td colspan="3">liquid use increases exponentially/faster «than solids or gas»
OR
greater liquid use than solids or gas in 1975
OR
greater solid use than liquids or gas in 1950
OR
least gas use throughout ✓</td></tr>
</table>
</td><td> 

[Source: Boden T ; Marland G ; Andres R J (1999): Global, Regional, and National Fossil-Fuel CO2 Emissions (1751 - 2014) (V. 2017). Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory (ORNL), Oak Ridge, TN (United States). doi:10.3334/ CDIAC/00001_V2017]</td><td>2</td></tr>
</table>

Section B

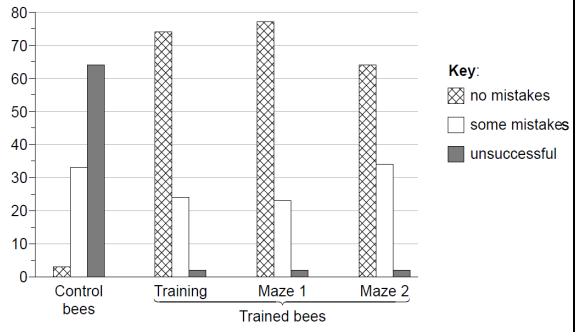
Option A — Neurobiology and behaviour

Question			Answers	Notes	Total
4.	**a**	**i**	X: semicircular canals ✓ Y: eardrum/tympanic membrane ✓		**2**
4.	**a**	**ii**	a. sound picked up by microphone relayed electronically to speech processor ✓ b. speech processor filters background noise/selects only speech frequencies ✓ c. **«**radio**»** signal from transmitter to receiver/stimulator which converts it to electric signal ✓ d. **«**electrical impulses**»** sent to electrode **«**array**»** in cochlea ***OR*** cochlear implant bypasses the hair cells in the cochlea ✓ e. electrode/electrical signal stimulates auditory nerve **«**fibers in cochlea**»** ✓ f. signals **«**generated by implant**»** sent to brain **«**which recognizes signals as sound**»** ✓	*OWTTE*	**3 max**

(continued…)

(Question 4 continued)

Question			Answers	Notes	Total
4.	**b**	**i**	cerebrum/cerebral hemisphere ✓		**1**
4.	**b**	**ii**	a. all «deaf and hearing» people show common pattern of brain activation/engage similar tissues ✓ b. all show two distinct areas, one in frontal/anterior region and another in back/posterior region ✓		**1 max**
4.	**b**	**iii**	a. to see whether results are valid/held across different cultural/linguistic groups ✓ b. to see whether results are specific to only one language ✓		**1 max**
4.	**b**	**iv**	a. active parts of brain receive increased blood flow ✓ b. harmless dye injected to make blood flow visible ✓ c. brain activity for specific tasks can be observed «in real time» ✓		**2 max**
4.	**b**	**v**	they might make mistakes in signing/naming/repetition «which is what they use to “speak”» ✓		**1**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>5.</td><td>a</td><td></td><td>
<table>
<tr><th></th><th>Innate behaviour</th><th>Learned behaviour</th></tr>
<tr><td>a.</td><td>genetically determined/inherited</td><td>acquired «skills/knowledge/experience» during lifetime ✓</td></tr>
<tr><td>b.</td><td>independent of environment</td><td>dependent of environment/experience ✓</td></tr>
<tr><td>c.</td><td>similar within the species
OR
spreads slowly through population</td><td>variable within the species
OR
spreads quickly through population ✓</td></tr>
</table>
</td><td>Not necessary to answer within a table.</td><td>2 max</td></tr>
<tr><td>5.</td><td>b</td><td>i</td><td>a. trained bees made few mistakes/were successful ✓
b. trained bees could use cues on two different mazes so able to remember «over time»
OR
bees who did well on training maze continued to do well on other mazes ✓
c. «approximately» same percentage/frequency of successful bees on training and other two mazes ✓
d. most control/untrained bees unable to find path through maze without mistakes
OR
most control/untrained bees always made mistakes ✓</td><td> 

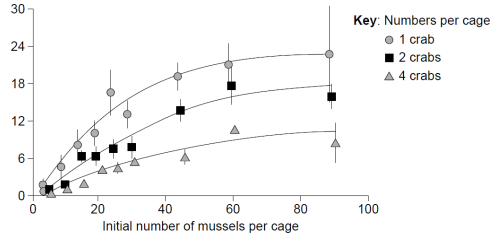
[Source: reprinted from Neurobiology of Learning and Memory, 72, S.W. Zhang et al, Honeybee Memory: Navigation by Associative Grouping and Recall of Visual Stimuli, 180–201, Copyright 1999, with permission from Elsevier]

Accept converse statements.</td><td>3 max</td></tr>
</table>

(continued…)

(Question 5 continued)

Question			Answers	Notes	Total
5.	**b**	**ii**	a. return to flowers with nectar ***OR*** **«**more chance**»** to obtain food ✓ b. increases chances of survival **«**if they can learn directions to and from food**»** ✓		**1 max**

6.	**a**	**i**	a. has eaten its full ✓ b. feeding depends on ratio of predator to prey ***OR*** when **«**certain**»** ratio of predator to prey is reached feeding/graph levels off ✓ c. prefers certain size mussel so only preys on these ✓	 [Source: reprinted from B D Griffen and D G Delaney, *Ecology*, **88** (12), pages 3012–3021, copyright 2007, with permission, the Ecological Society of America]	**1 max**
6.	**a**	**ii**	a. **«**foraging**»** depends on number of predators/crabs ✓ b. mean number of mussels/prey consumed per crab decreases as number of crabs increases ✓ c. crabs compete for prey/mussels ✓ d. both **«**prey and predator**»** affect foraging success ✓	*Accept vice versa.*	**2 max**
6.	**b**		a. genetically based/innate behavior can be passed on to offspring ✓ b. behavior increases chances of survival and reproduction ✓ c. will increase in frequency/become more prevalent in a population ✓		**2 max**

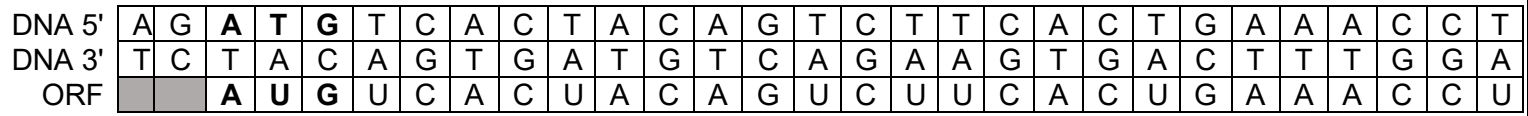
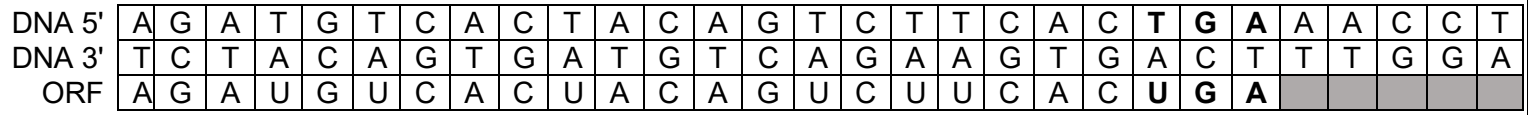
Question			Answers	Notes	Total
7.			a. neural tube formed by infolding of ectoderm/outer tissue layer ✓ b. «spina bifida» caused by «embryonic» neural tube not closing off completely ✓ c. « spina bifida» results in backbone vertebrae/spinal cord not closing/fusing properly ✓	*Award marks for marking points in an annotated diagram.*	**2 max**

8.			a. pain receptors/ends of sensory neurons send impulses to cerebral cortex creating sensation of pain ✓ b. endorphins interfere with neural transmission between areas of pain perception and CNS ✓ c. endorphins produced/secreted «primarily» by pituitary gland ✓ d. endorphins secreted during times of physical exercise/emotional stress ✓ e. endorphins bind to «opiate» receptors at «pre/post»synaptic membrane ✓ f. prevent neurotransmitters binding to postsynaptic membrane/cell ✓ g. decrease transmission at postsynaptic membrane ***OR*** are inhibitory neurotransmitters ✓ h. effects have slow onset but last long time «minutes/hours» ✓ i. act as natural painkiller ***OR*** produce feeling of euphoria ✓		**6 max**

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
9.	**a**	**i**	flavour enhancer/«food» preservative ✓		**1**
9.	**a**	**ii**	*Aspergillus niger* ✓	*Both names in full required.*	**1**
9.	**b**	**i**	glucose/fructose ✓		**1**
9.	**b**	**ii**	a. both show lag phase/no/little change in concentration at the beginning ✓ b. «after lag phase» citric acid concentration increases while sucrose concentration decreases ***OR*** «after lag phase» citric acid shows continued increase while sucrose falls to 0 ✓		**2 max**
9.	**c**		a. fermentation carried out by batch/continuous culture ✓ b. microorganisms use sugar for their own metabolism/fermentation ✓ c. microorganisms may become limited by their own waste products ✓ d. «probes used to» monitor conditions within fermenters ✓ e. best conditions maintained «for growth of microorganisms being cultured» ✓		**3 max**

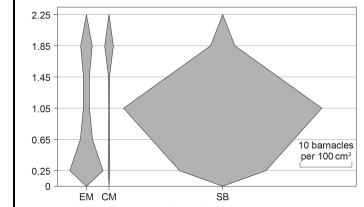
Question			Answers	Notes	Total
10.	**a**	**i**	a. cells/bacteria in a biofilm are close together ✓ b. cells secrete signaling molecules ✓ c. **«**signaling molecules**»** bind to receptors of other cells ***OR*** **«**signaling molecules**»** allow communication between cells ✓ d. a threshold is reached which enables emergent properties ✓		**2 max**
10.	**a**	**ii**	a. polysaccharide matrix/EPS does not let antibiotic pass/limits transport of antibiotic ✓ b. reduced metabolic activity/growth rate of bacteria in biofilm contributes to resistance ✓ c. increased cell density limits transport of antibiotic **«**to the interior of biofilm**»** ✓ d. **«**horizontal**»** transfer of antibiotic resistance via plasmids ✓	*OWTTE*	**1 max**
10.	**b**		a. area where biofilm problem exists ✓ b. environmental concern ✓	*eg emptying introduces invasive bacterial species into coastal waters.* *Allow other verified examples.*	**2**

Question			Answers	Notes	Total
11.	**a**		a. correct starting point ✓ *eg*  ***OR***  b. correct RNA nucleotides ✓		**2**
11.	**b**	**i**	identify a sequence/gene **«**that has the potential to be transcribed**»** ✓		**1**
11.	**b**	**ii**	silence gene to observe the effect when the gene is not expressed ***OR*** change in phenotype to deduce function of gene ✓		**1**
11.	**b**	**iii**	to compare nucleotide/DNA sequence with other **«**nucleotide**»** sequences ✓		**1**

Question			Answers	Notes	Total
12.	a		***ALTERNATIVE 1*** a. *Agrobacterium tumefaciens* contains a tumour-inducing/Ti plasmid ✓ b. required/target gene inserted into plasmid ✓ c. bacterium injects modified plasmid into plant cell and DNA becomes incorporated into plant cell nucleus ✓ ***ALTERNATIVE 2*** d. tobacco mosaic virus/TMV is the vector ✓ e. required/target gene inserted into TMV ✓ f. TMV injects modified DNA into plant cell **«**and DNA becomes incorporated into plant cell nucleus**»** ✓		**2 max**
12.	b		to verify that the target gene has been incorporated in the target cell/organism ✓	*OWTTE*	**1**
12.	c		a. gene for human antithrombin **«**fused with goat DNA and**»** inserted into **«**goat**»** embryos by microinjection ✓ b. embryos inserted into recipient female ✓ c. test offspring for antithrombin **«**in milk during induced lactation**»** ✓ d. breed selected offspring/clones that produce antithrombin **«**in milk**»** ✓ e. purify antithrombin from milk ✓	*Accept other verified animals eg: sheep, cows.*	**3 max**

Question			Answers	Notes	Total
13.			a. DNA spots/probes/sequences attached to solid surface/microarray ✓ b. mRNA from healthy tissue/cell isolated and converted to cDNA ***OR*** mRNA from cancer tissue/cell isolated and converted to cDNA ✓ c. conversion to cDNA by reverse transcriptase ✓ d. fluorescent dye linked to copy DNA/cDNA ✓ e. cancer cDNA colored with a different dye from the healthy cDNA ✓ f. cDNA binds to/hybridizes with probes that have complementary base sequences ✓ g. microarray rinsed to remove cDNA that has not hybridized ✓ h. microarray exposed to laser light which causes fluorescent dye to give off light ✓ i. fluorescence shows which probes have hybridized ***OR*** fluorescence shows which sequences were in the tissue/sample ✓ j. hybridized probe shows gene expression ***OR*** hybridized probe helps in diagnosis of disease ✓ k. infection by pathogen can be detected by presence of its genetic material ✓	*Accept named colour.*	**6 max**

Option C — Ecology and conservation

Question			Answers	Notes	Total
14.	**a**		a. transect across area to be studied ✓ b. count/record barnacles «per species» in quadrats at regular intervals ✓		**2**
14.	**b**		a. both species present throughout the range ✓ b. *C. montagui* has a small number of individuals «throughout» OR *C. montagui* occupies «mostly» upper shore/intertidal zone ✓ c. *S. balanoides* has large number of individuals «throughout» ***OR*** *S. balanoides* «mostly» occupies low tide area ✓		**2**
14.	**c**		a. native species/*C. montagui* and *S. balanoides* have niches that don't overlap much/are distinct ***OR*** range of *E. modestus* overlaps with both native species ✓ b. niches of native species don't overlap much which shows competition between native species ***OR*** *E. modestus* invades habitats of *C. montagui*/*S. balanoides* resulting in competition with both native species ✓ c. *E. modestus/EM* has a wide niche/higher tolerance/covers entire «intertidal» range making it easier to invade the habitat ✓	 [Source: reprinted from *Estuarine Coastal and Shelf Science*, **152**, M C Gallagher, *et al.*, The invasive barnacle species, Austrominius modestus: Its status and competition with indigenous barnacles on the Isle of Cumbrae, Scotland, pages 134–141, 2014 with permission from Elsevier]	**2 max**

(continued…)

(Question 14 continued)

14.	**d**		a. indicator species need particular environmental conditions ***OR*** indicator species tolerate only certain environmental conditions ✓ b. increase/decrease in population size «over time» shows effect of environmental conditions ✓ c. used to calculate biotic index/index of cleanliness ✓ d. index of 10/high index number indicates totally unpolluted ***OR*** index of 2 or 1/low index number indicates severe pollution ✓		**2 max**

Question			Answers	Notes	Total
15.	**a**	**i**	**«** 30 – 26 = **»** 4 **«** °C **»** ✓	*Accept answers between 3 to 5 «°C».*	**1**
15.	**a**	**ii**	maximum temperature occurs just when rainfall begins/at the onset of the rainy season/monsoon ***OR*** negative relationship **«**as maximum temperature drops, rainfall increases**»** ✓	*OWTTE*	**1**
15.	**a**	**iii**	rainfall concentrated between April to December/peaks in June-August **«**followed by months with little/no rainfall**»** ✓	*OWTTE*	**1**
15.	**b**		a. dry season/Jan/Feb ✓ b. **«**drop leaves**»** to prevent water loss/transpiration **«**since no rainfall for almost four months**»** ✓		**2**
15.	**c**		a. statement correctly explaining the quantity of nutrients in identified circle/circles ✓ b. statement correctly explaining high nutrient flow/transfer of any thick/large arrow ✓ c. statement correctly explaining low nutrient flow/transfer of any thin arrow ✓ d. any statement correctly comparing nutrient storage/flow rates ✓ e. a Gersmehl diagram models **«**interrelationships between**»** nutrient stores and flows in an ecosystem ✓	*eg most nutrients are stored in biomass/equal quantities of nutrients stored in soil and litter.* *eg high transfer rate of nutrients from soil to biomass.* *eg low transfer rate of nutrients from litter to the outside/another ecosystem.* *eg higher nutrient transfer between soil and biomass than between biomass and litter OWTTE.*	**3 max**

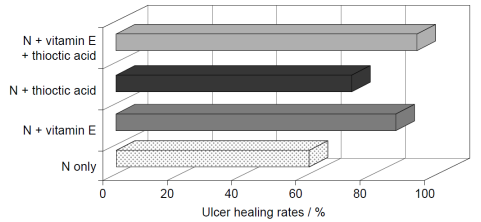
Question			Answers	Notes	Total
16.	**a**		a. ideal environment/unlimited resources/below carrying capacity ✓ b. little disease/few predators ✓ c. high natality/birth rate ***AND*** immigration ✓ d. natality and immigration <u>greater</u> than mortality and emigration ✓	*Both needed.*	**3 max**
16.	**b**		a. carrying capacity is maximum population size/number of individuals that environment can support ***OR*** carrying capacity varies with abundance of limiting resources ✓ b. population growth slows/fluctuates as the carrying capacity of environment reached ✓		**2 max**

17.			a. name of organism ✓ b. why endangered ✓ c. where bred ✓ d. how programme carried out ✓ e. success rate ✓	*To award **[3]** name of organism, either scientific or correct common name, must be given.* *eg <u>Giant</u> panda* *eg loss of habitat/hunted for fur* *eg in zoos/ex situ/in situ/China* *eg bred/raised in captivity* *eg relative success re: introducing to wild/some reproduction in zoos*	**3 max**

Question			Answers	Notes	Total
18.			a. adding fertilizer increases nitrogen/phosphate in soil/nutrient cycles ✓ b. adding fertilizer increases crop yield ✓ c. commercial fertilizers may not stay in ground as long as organic fertilizers/manure ✓ d. commercial fertilizers release compounds more rapidly than organic fertilizers/manure ✓ e. nutrients run off/leached from land into water/groundwater/lakes/streams ✓ f. **«**high concentrations of nitrogen/phosphate in water**»** causes eutrophication ✓ g. **«**high concentrations of nitrogen/phosphate**»** causes algae to multiply rapidly ***OR*** leads to algal blooms ✓ h. algae die and decomposed by bacteria ✓ i. **«**decomposers**»** require oxygen from water ***OR*** increased biochemical oxygen demand/BOD ✓ j. if oxygen levels drop too low fish/aquatic organisms die ✓		**6 max**

Option D — Human physiology

Question			Answers	Notes	Total
19.	**a**		hepatic artery ✓		**1**
19.	**b**		a. both produce pyruvate **«**from lactate**»** ***OR*** both produce CO_2 and H_2O **«**via acetyl CoA**»** ✓ b. hepatocytes produce glucose from lactate but mitochondria-rich cells cannot ✓	*OWTTE – eg: "only hepatocytes produce glucose" would be acceptable.*	**2**
19.	**c**		a. detoxification ✓ b. production/secretion of bile ✓ c. conversion of cholesterol to bile salts ✓ d. production of plasma proteins ✓ e. nutrient storage ✓ f. glucose regulation **«**in blood**»** ✓ g. other function **«***eg* deamination/transamination, conversion of ammonia to urea**»** ✓	*Only **two** functions are required.*	**2**

Question			Answers	Notes	Total
20.	**a**		*Helicobacter pylori* ✓	*To award **[1]** full scientific name is required.*	**1**
20.	**b**		a. vitamin E and thioctic acid both improve healing rate «compared with nizatidine alone» ***OR*** all trials with antioxidant/three trials improve healing rate «compared to N alone» ✓ b. adding vitamin E increases healing rate more than adding thioctic acid ***OR*** adding both vitamin E and thioctic acid increases healing rate to highest level «but still less than 100 %» ✓	*Giving values alone is not enough.*  [Source: Effect of Helicobacter Pylori Eradication Therapy and some Antioxidants on Ulcer Healing Rates in Patients with Helicobacter pylori-associated Duodenal Ulcer, Ahmed M Ali, 2013, http://www.rroij.com/open-access/effect-of-helicobacter-pylori-eradication-therapy-and-some-antioxidants-on-ulcer-healing-rates-in-patients-with-helicobacter-pylor-.php?aid=34774, licensed under a Creative Commons Attribution 4.0 International License]	**2**

(continued…)

(Question 20 continued)

Question			Answers	Notes	Total
20.	**c**		a. sight/smell of food stimulates brain ✓ b. food entering stomach stimulates chemoreceptors/stretch receptors to send impulses/signals to brain ✓ c. impulse/signal from brain causes cells in stomach lining/parietal cells to secrete acid/HCl/gastric juice ✓ d. brain sends impulses/signals **«**via vagus nerve**»** to endocrine cells in wall of stomach to release gastrin ✓ e. gastrin stimulates **«**more**»** production of acid/HCl/gastric juice ✓		**3 max**
20.	**d**		a. bind to <u>plasma</u> membrane receptors of **«**target**»** cell ✓ b. results in activation/release/synthesis of a secondary messenger ✓ c. triggers a cascade of reactions ✓ d. leads to promotion/inhibition of enzymes ***OR*** causes activation of protein kinase **«**resulting in hormonal effect**»** ✓		**3 max**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>21.</td><td>a</td><td>i</td><td>Northern Territory ✓</td><td></td><td>1</td></tr>
<tr><td>21.</td><td>a</td><td>ii</td><td>less sun in winter than in summer
OR
colder in winter so cover up/indoors more
OR
skin has more exposure to sun in summer ✓</td><td>Accept other valid suggestions.

Accept vice versa.</td><td>1 max</td></tr>
<tr><td>21.</td><td>b</td><td></td><td>a. «lack of vitamin D results in» calcium «ions» not absorbed from gut in sufficient quantities ✓
b. calcium salts not deposited or reabsorbed
OR
affects bone mineralization ✓
c. bones become softened/weakened ✓
d. can cause rickets «in children»/osteomalacia «in adults» ✓</td><td></td><td>2 max</td></tr>
<tr><td>21.</td><td>c</td><td></td><td>
<table>
<tr><th></th><th colspan="2">Vitamins</th><th>Minerals</th></tr>
<tr><td>a. similarity/comparison</td><td colspan="3">both required in minute/small quantities/are micronutrients
OR
both obtained in diet ✓</td></tr>
<tr><td rowspan="3">b. difference/contrast</td><td colspan="2">organic molecules/compounds</td><td>inorganic/ions/elements</td></tr>
<tr><td colspan="3">OR</td></tr>
<tr><td colspan="2">example of function
eg essential in metabolic processes</td><td>example of function
eg maintaining osmolarity/synaptic transmission ✓</td></tr>
</table>
</td><td>Not necessary to present answer in a table.

Accept other valid similarities and/or differences.

Award marks for complete lines only.</td><td>2</td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>22.</td><td>a</td><td></td><td>a. relays signal from SAN to ventricles ✓
b. causes ventricular systole ✓
c. delays signal enabling both ventricles to contract simultaneously
OR
delays signal so the atria empty before ventricular systole ✓</td><td></td><td>1 max</td></tr>
<tr><td>22.</td><td>b</td><td></td><td>
<table>
<tr><th></th><th>structure</th><th>function</th></tr>
<tr><td>a.</td><td>intercalated discs</td><td>form connections between cells/join cells together/strong adhesion/prevent cells from pulling apart/resist mechanical stress ✓</td></tr>
<tr><td>b.</td><td>cytoplasmic connections between cells/gap junctions</td><td>allow passage of ions/propagate rapid electrical stimuli between cells/allow coordinated contraction ✓</td></tr>
<tr><td>c.</td><td>striations/thick and thin muscle fibers</td><td>form the mechanism for contraction ✓</td></tr>
<tr><td>d.</td><td>abundance of mitochondria</td><td>produce supply of energy for continuous contractions ✓</td></tr>
<tr><td>e.</td><td>branched/Y-shaped cells</td><td>allow for rapid propagation/faster coordinated contraction ✓</td></tr>
</table>
</td><td>Not necessary to present answer in a table.

Award [1] for each set of corresponding structure and function.</td><td>3 max</td></tr>
</table>

Question			Answers	Notes	Total
23.				*Some of these points may be present in annotated diagrams.*	**6 max**
			a. oxyhemoglobin forms when partial pressure of oxygen is high ***OR*** oxyhemoglobin dissociates/breaks apart when partial pressure of oxygen is low ✓		
			b. respiring tissues have low partial pressure of oxygen ✓		
			c. sketch/statement of S-shaped **«**oxygen dissociation**»** curve ✓		
			d. axes of graph labelled correctly as percentage oxygen saturation of hemoglobin on *y*-axis ***AND*** partial pressure of oxygen on *x*-axis ✓	*Both needed.* *Do not accept reverse axes.*	
			e. **«**small**»** decrease in oxygen partial pressure over steep part of curve results in dissociation of oxyhemoglobin/oxygen release to tissues ✓		
			f. fetal hemoglobin is structurally different from adult/maternal hemoglobin ✓		
			g. fetal dissociation curve to left of adult dissociation curve ✓		
			h. fetal hemoglobin has greater affinity for oxygen than adult/maternal blood ✓		
			i. fetus obtains its oxygen from mother's blood **«**at placenta**»** ✓		
			j. at any given partial pressure of oxygen fetus will take up oxygen from mother ***OR*** fetal hemoglobin always more saturated with oxygen than maternal blood ✓		