

# Markscheme

November 2016

Biology

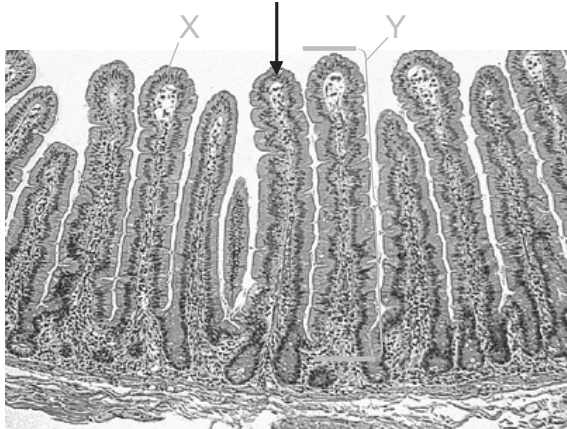
Higher level

Paper 3

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**Section A**

Question		Answers	Notes	Total
1.	a	<p>positive correlation</p> <p><b>OR</b></p> <p>faster hydrolysis at higher concentration ✓</p>		1
	b	<p>curve with similar shape between papain 0.1% and 1% ✓</p> <p>eg:</p> <p>Key:</p> <ul style="list-style-type: none"> <li>◆ papain 1%</li> <li>▲ pancreatin 1%</li> <li>◇ papain 0.1%</li> <li>△ pancreatin 0.1%</li> </ul>	<p><i>Curve to start at 0.</i></p> <p><i>Allow a similar/same shaped curve to papain 1% to be anywhere within the shaded area shown on the graph.</i></p>	1
	c	<p>a. hydrolysis of protein produces hydrogen ions/amino acids ✓</p> <p>b. pH decreases / increased acidity ✓</p> <p>c. causing <u>denaturation</u> of enzyme/pancreatin/papain ✓</p> <p>d. decrease of reaction «rate»/no hydrolysis ✓</p> <p>e. enzymes work best at the optimum pH / OWTTE ✓</p>		3 max

Question		Answers	Notes	Total
2.	a	<u>small</u> intestine ✓	<i>Do not accept villus/villi or intestine alone.</i>	1
	b	epithelium ✓	<i>Do not accept microvilli/brush border.</i>	1
	c	a. calculation shown with accurate measurement of length of villus <b>OR</b> $\frac{53}{0.8}$ or $\frac{54}{0.8}$ or $\frac{55}{0.8}$ «mm» ✓  b. 67 or 68 or 69 ✓	<i>For the first marking point to be awarded, the measurement must be between 53 and 55 mm.</i>  <i>Allow any value between 67 and 69 inclusive.</i> <i>Accept decimals, eg, 68.75.</i> <i>Allow ECF from first marking point.</i>	2
	d			1

Question		Answers	Notes	Total
3.	a	a. <u>aphids</u> insert stylet in «potato» plants/feed from «potato» plants ✓ b. phloem exudates/sap obtained from severed <u>stylets</u> ✓	“Aphids” is essential for the mark.  “Stylets” is essential for the mark.	2
	b	a. sucrose produced by leaves during photosynthesis ✓ b. sucrose moves/translocates from source/leaves to sink/roots/tubers <b>OR</b> sucrose carried by phloem to tuber ✓ c. «wk 5» high sucrose with increased leaf growth/photosynthesis / OWTTE ✓ d. «wk 5-7» more sucrose used for general plant growth / OWTTE ✓ e. «wk 7-11» concentration sucrose increases due to greater production/photosynthesis «than usage/storage» / OWTTE ✓ f. sucrose transformed into starch in tuber «from week 9» ✓ g. contribution of amino acids unknown so difficult to know about different amounts of sucrose / OWTTE ✓ h. «abiotic» conditions in greenhouse may vary over time / OWTTE ✓	Award the mark for realizing that amino acids play a role in the ratio. Accept abiotic factors only if variation through time is explicit.	3 max

**Section B**

**Option A — Neurobiology and behaviour**

Question		Answers	Notes	Total
4.	a	neuron pruning <b>OR</b> synapses removed ✓	<i>Do not accept “apoptosis”.</i>	1
	b	a. more synapses maintained with stimulation/mental activity/OWTTE ✓ b. strong mental activity prevents «neuron» pruning ✓		2 max
	c	a. most synapses are formed during childhood/before birth <b>OR</b> first years of childhood most important for brain development ✓ b. more synapses «than normal» may be formed «during childhood/before birth in autism» ✓ c. «in autism» pruning of neurons does not occur «causing excess of synapses» <b>OR</b> normal synapse elimination does not remove extra synapses ✓		2 max

Question		Answers	Notes	Total
5.	a	<p>a. «fMRI» allows imaging through magnetic resonance ✓</p> <p>b. to measure the amount of activity/blood flow in different parts of the brain <b>OR</b> to identify the parts of the brain that are activated ✓</p> <p>c. non-invasive/indirect observation/real time observation ✓</p>		2 max
	b	<p>a. THC causes a negative/inhibitory mean activation of parahippocampus whereas CBD causes a positive/excitatory one <b>OR</b> THC and CBD cause opposite effects on parahippocampus ✓</p> <p>b. both cause a positive/excitatory «mean activation» of the visual cortex ✓</p> <p>c. «magnitude» of mean activation of both ingredients is minute on parahippocampus compared to visual cortex/OWTTE ✓</p> <p>d. mean activation due to THC lower than CBD for both «parahippocampus and visual cortex» <b>OR</b> mean activation due to THC lower than placebo whereas higher for CBD for both ✓</p> <p>e. other valid comparison/contrast between the two drugs ✓</p>		3 max
	c	processing visual information/signals from the optic nerve/OWTTE ✓		1

Question		Answers	Notes	Total
6.	a	a. «usually» autonomic reflex ✓ b. «usually» involuntary/automatic <b>OR</b> not controlled consciously ✓ c. coordinated by medulla «oblongata» ✓ d. can be voluntary/consciously controlled «by cerebral cortex» ✓		3 max
	b	a. learned behaviour is behaviour that is taught or received through experience ✓ b. named organism ✓ c. named/description of behaviour ✓	Allow other definition. eg: Chimpanzees. Allow human, people, etc, providing it is explicitly written. eg: Sticks used to spear juicy grubs. eg: learning a language.	3 max
7.	a	a. I: cochlea ✓ b. II: round window ✓ c. III: eardrum ✓		3
	b	amplify/transmit the sound/vibrations ✓		1



Question		Answers	Notes	Total
	c	<p>a. hair cells located within the organ of Corti <b>OR</b> hair cells are mechanoreceptors ✓</p> <p>b. hairs/cilia of hair cells move/vibrate with the movement of the liquid/fluid in the cochlea ✓</p> <p>c. amount of movement is proportional to the amplitude/loudness of the sound ✓</p> <p>d. frequency/wavelength/pitch distinguished by different hair cells/according to position of hair cells/length of hairs/cilia ✓</p> <p>e. hair cells transmit impulses to auditory nerve/brain ✓</p>		3 max

Question	Answers	Notes	Total
8.	<p>a. patient loses awareness/does not feel pain/analgesia ✓</p> <p>b. interfere/block neural/synaptic transmission between «areas of» sensory perception and the CNS <b>OR</b> block «sensory» neural pathways to the brain that detect pain ✓</p> <p>c. increase presynaptic inhibition <b>OR</b> block receptors on the presynaptic membrane ✓</p> <p>d. increase release of inhibitory neurotransmitters <b>OR</b> prevent release of excitatory neurotransmitters ✓</p> <p>e. inhibit binding of neurotransmitters «to receptors» on postsynaptic membrane ✓</p> <p>f. decrease «likelihood of» depolarization of the postsynaptic neuron <b>OR</b> hyperpolarize the postsynaptic neuron ✓</p> <p>g. prevent propagation of action potential on the postsynaptic neuron ✓</p> <p>h. vital physiological functions/breathing/maintenance of blood pressure continue to function ✓</p> <p>i. the effects are reversible ✓</p> <p>j. anesthetics mimic effect/stimulate release of endorphins «which are natural painkillers»/OWTTE ✓</p>		6 max

**Option B — Biotechnology and bioinformatics**

Question		Answers	Notes	Total
9.	a	a. the antibiotic/ampicillin diffuses out ✓ b. killing bacteria/inhibiting growth of bacteria ✓ c. zone of inhibition/clearing formed ✓		2 max
	b	lipid A production/synthesis is not inhibited so bacteria can grow <b>OR</b> bacteria grow/are not affected since inhibitor function is lost ✓		1
	c	no inhibition of growth, since Gram-positive do not have lipid A in membrane/OWTTE ✓		1

10.	a	a. kanamycin resistance as marker gene ✓ b. when organisms grown in kanamycin, only resistant survive <b>OR</b> those that took up resistance/cloned ones survive ✓		2
	b	database/NCBI search to find target gene/OWTTE <b>OR</b> search for target gene in other/related organisms ✓	<i>Allow other named database. Please check unfamiliar names for authenticity.</i>	1
	c	a. more wax deposition constituents «in leaves» of transgenic than control plants ✓ b. wax is waterproof ✓ c. less evaporation from «waxy» leaves «protects from drought» ✓		2 max

Question		Answers	Notes	Total
	<b>d</b>	a. metal/tungsten/gold/bullet is coated with DNA/gene ✓ b. «this DNA is» fired/shot into a leaf «containing the target cells» ✓ c. DNA is released and incorporated into some of the cells ✓		<b>2 max</b>
<b>11.</b>	<b>a</b>	a. named metabolite ✓ b. associated disease ✓	eg: <i>glucose</i> eg: <i>diabetes</i>	<b>2</b>

Question	Answers	Notes	Total
b	a. production of pharmaceuticals <b>OR</b> named example of biopharming ✓ b. easily scaled to cover demands <b>OR</b> cheaper ✓ c. drugs can be delivered in food «making it more attractive/easier to eat» ✓ d. unethical/ethical aspect/OWTTE ✓ e. allergic reactions/ side effects ✓ f. horizontal gene transfer consideration ✓		4 max

Question			Answers	Notes	Total
12.	a		BLASTp ✓	<i>Do not allow "BLAST" alone but accept BLASTx.</i>	1
	b		gap/no amino acid present «for cytochrome c in that organism in that position» <b>OR</b> protein is shorter ✓		1
	c	i	GLFGR ✓	<i>Can be shown directly on the alignment.</i>	1
	c	ii	no, because more than one codon can code for an amino acid/degeneration of the genetic code ✓		1

Question	Answers	Notes	Total
<p><b>d</b></p>	<p><b>ALTERNATIVE 1</b></p> <p>a. alignment used to quantify differences and similarities ✓</p> <p>b. algorithms for cladograms</p> <p><b>OR</b></p> <p>named algorithms ✓</p> <p>c. selection of best model ✓</p> <p><b>ALTERNATIVE 2</b></p> <p>d. comparing amino acid sequences between organisms ✓</p> <p>e. more similar sequences correspond to closer evolutionary links/OWTTE</p> <p><b>OR</b></p> <p>number of differences indicate number of mutations accumulated «over time»</p> <p><b>OR</b></p> <p>«if mutation rate is assumed to be constant», more mutations imply further evolutionary distance ✓</p> <p>f. length of lines/position of nodes established by the number of differences/mutations between organisms ✓</p>	<p><i>Marks should be awarded for statements from only one alternative, not both.</i></p> <p><i>Named algorithms: least squares, neighbour-joining, parsimony, maximum likelihood or Bayesian inference.</i></p> <p><i>Allow other verifiable algorithms.</i></p>	<p><b>2 max</b></p>
<p><b>e</b></p>	<p><i>Zea</i> «corn» <u>and</u> <i>Oryza</i> «rice» ✓</p>	<p><i>Both required.</i></p>	<p><b>1</b></p>

Question	Answers	Notes	Total
13.	<p><i>Formation</i></p> <p>a. biofilm is a group of microorganisms embedded in a «exopolysaccharide/EPS» matrix ✓</p> <p>b. microorganisms adhere on a surface/to each other ✓</p> <p>c. cells are able to communicate/cooperate via quorum sensing  <b>OR</b>                      secrete molecules that facilitate the aggregate adhering to the surface  <b>OR</b>                      facilitate individual cells sticking together/OWTTE ✓</p> <p>d. phenotypic shift in behaviour  <b>OR</b>                      emergent properties appear  <b>OR</b>                      differential regulation of genes ✓</p> <p><i>Problems</i></p> <p>e. «formation of biofilms» in the body facilitates infections/OWTTE ✓</p> <p>f. clogging/corrosion of pipes in water systems ✓</p> <p>g. transfer of microorganisms in ballast water ✓</p> <p>h. contamination of surfaces in food production ✓</p> <p>i. highly resistant to antimicrobial agents/antibiotics ✓</p> <p>j. EPS provides a physical barrier to the entry of the antibiotic «into the colony» ✓</p>	<p><i>Award [5 max] if only problems are mentioned.</i></p> <p><i>Accept any verifiable health problem caused by biofilms, e.g. dental plaque causing caries, lung infection in cystic fibrosis patients, etc.</i></p>	6 max



Option C — Ecology and conservation

Question		Answers	Notes	Total
14.		a. the realized niche is the actual while the fundamental niche is «all of» the potential ✓ b. «shared» fundamental niche shown by equal reproduction on control ✓ c. <i>C. neoformans</i> reproduces on PD indicating a realized ecological niche ✓ d. <u>competitive exclusion</u> decreases realized niche of <i>C. gattii</i> ✓ e. <i>C. gattii</i> reproduces poorly on PD representing a fundamental niche <b>OR</b> <i>C. gattii</i> reproduces poorly on PD so not a realized niche ✓		3 max
15.	a	plastic bottles <b>OR</b> fishing gear <b>OR</b> plastic bags <b>OR</b> plastic wrappers ✓	Award <b>[1]</b> for any source. Allow any other valid named source.	1

Question		Answers	Notes	Total
	<b>b</b>	a. ingestion can reduce feeding <b>OR</b> false feeling of satiation ✓  b. microplastics absorb toxins from water ✓  c. filter feeders ingest the microplastics with the toxins ✓  d. biomagnifications/bioaccumulation ✓		<b>2 max</b>
	<b>c</b>	a. microplastic density higher along the «north» western shore than the eastern shore <b>OR</b> wind blows plastics to opposite coast <b>OR</b> wind blows plastics away from their source/city/camping grounds <b>OR</b> wind increases degradation of macroplastics into microplastics ✓  b. wind causes currents which moves the plastics ✓  c. macroplastic pollution less affected by wind than microplastic pollution ✓		<b>2 max</b>
	<b>d</b>	a. improve city waste disposal ✓  b. recycling programs <b>OR</b> develop community service teams to collect plastics «around the lake»/OWTTE ✓  c. place litter containers/garbage cans close to camping sites ✓  d. fines for those causing pollution <b>OR</b> pass littering laws ✓		<b>3 max</b>

Question		Answers	Notes	Total
16.	a	<p><b>ALTERNATIVE 1</b></p> <p>a. transect through a given area ✓</p> <p>b. trees counted on transect ✓</p> <p>c. calculation of total population considering area ✓</p> <p><b>ALTERNATIVE 2</b></p> <p>d. random sampling using quadrats ✓</p> <p>e. trees counted in quadrat ✓</p> <p>f. population calculated using area ✓</p> <p><b>ALTERNATIVE 3</b></p> <p>g. GPS/Google Earth used to map individuals of a tree species ✓</p> <p>h. data base of data obtained ✓</p> <p>i. population density calculated using area ✓</p>		3

Question		Answers	Notes	Total
	<b>b</b>	a. edge effect are the changes in community structures that occur at the boundary of two habitats ✓ b. areas with small habitat fragments exhibit especially pronounced edge effects ✓ c. edge species will always have a habitat <b>OR</b> edge biodiversity increases ✓ d. if patches of forest are too small the non-edge species cannot find a habitat ✓ e. «then» overall non-edge biodiversity is lower ✓		
	<b>c</b>	a. same richness as they have the same number of species/total of individuals ✓ b. field 1 has more evenness as more even distribution of numbers among the species ✓	Accept correct use of Simpson diversity index.	<b>2</b>

Question		Answers	Notes	Total
17.	a	minerals <b>OR</b> nutrients <b>OR</b> phosphorus <b>OR</b> nitrogen ✓	Award <b>[1]</b> to any two factors stated. Accept abiotic factors such as temperature, light, pH, CO <sub>2</sub> concentration.	2
	b	a. the herbivores / «first» consumers regulate algal bloom ✓ b. predators of the herbivores help regulate algal bloom/reduce herbivore abundance/OWTTE ✓ c. overfishing/death of predators/decreased reproduction of predators decreases algal bloom as herbivore population increases/OWTTE ✓ d. habitat degradation can decrease algal bloom ✓ e. pathogens of algae will decrease algal bloom <b>OR</b> alien/invasive species may compete for habitat and affect algal bloom/OWTTE ✓	Accept vice versa for marking point c.	3

Question	Answers	Notes	Total
18.	<p><i>Natural cycle</i></p> <ul style="list-style-type: none"> <li>a. plants absorb phosphorus from the soil by the roots ✓</li> <li>b. soil phosphorus comes from weathered «phosphate» rocks ✓</li> <li>c. «soil/organic» phosphorus «also» comes from humus/plant/animal residues/guano/microorganisms ✓</li> <li>d. phosphorus is a limiting «macronutrient» factor in plant growth  <b>OR</b>                      phosphorus is necessary for vital functions/ATP/DNA  <b>OR</b>                      deficiency of phosphorus «in soil» limits plant growth/production ✓</li> </ul> <p><i>Sustainability</i></p> <ul style="list-style-type: none"> <li>e. «natural» phosphorus cycle is slow/not sustainable with increased crop production ✓</li> <li>f. phosphorus is replenished «in the soil» by use of mineral/organic fertilizers ✓</li> <li>g. phosphorus/phosphate is «mainly» mined from «phosphate» rocks ✓</li> <li>h. rocks are becoming used up/inaccessible so non-sustainable/non-renewable  <b>OR</b>                      the use of fertilizers is non-sustainable «with increased crop production» ✓</li> <li>i. increased demand for food/meat/dairy/grain increases demand for fertilizers ✓</li> <li>j. runoff/erosion/leaching of fertilizers decreases potential supply for crops/OWTTE ✓</li> </ul>		<b>6 max</b>

Option D — Human physiology

Question		Answers	Notes	Total
19.	a	a. less incidence of diabetes/more effective than placebo/control ✓ b. but less effective than change in lifestyle ✓ c. incidence nevertheless increases over the years ✓ d. possibly ideal would be to combine both «anti-diabetic drugs and lifestyle» <b>OR</b> lifestyle and anti-diabetic drugs not tried together «so we do not know the outcome» ✓		2 max
	b	a. overweight patients <b>OR</b> obesity ✓ b. sedentary lifestyle ✓ c. high glucose diet <b>OR</b> high glucose level in blood ✓ d. genetic predisposition ✓ e. other valid risk factor ✓		2 max

Question			Answers	Notes	Total
20.	a	i	a. second messenger correctly labelled ✓	<p><i>Do not accept steroid hormone/protein complex.</i></p> <p>eg:</p>	2
	a	ii	b. gene regulatory protein correctly labelled ✓		
	b		<p>a. lipid-soluble/non-polar/hydrophobic molecules «that readily diffuse through cell membranes» ✓</p> <p>b. small enough to diffuse through membrane ✓</p>	<p><i>Since the questions asks to “outline” a brief account is necessary to gain the mark.</i></p>	1 max



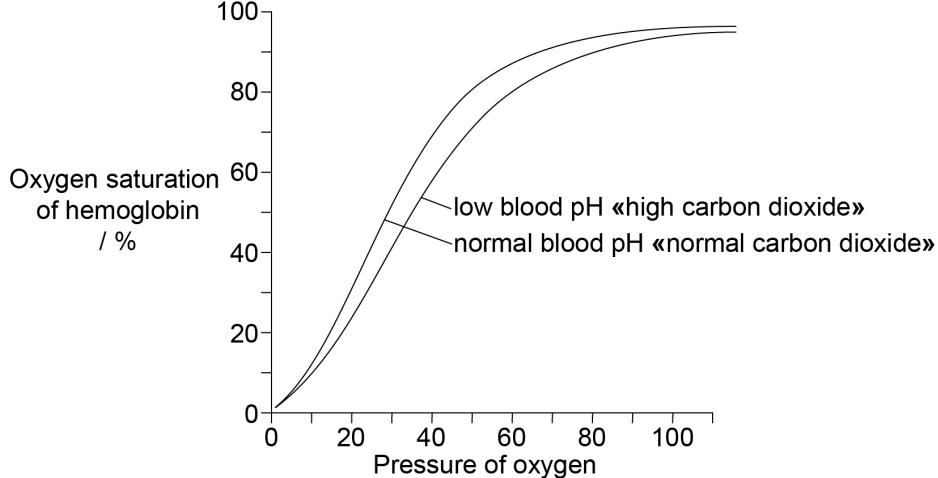
Question		Answers		Notes	Total	
c			peptide hormones	steroid hormones	<i>Answers do not need to be presented as a table. Award marks for pairs of corresponding elements on the same line of this table.</i>	<b>2 max</b>
	a.	receptor on plasma membrane <b>OR</b> do not enter cell	receptor within the cytoplasm <b>OR</b> enter the cell ✓			
	b.	activate second messenger/cyclic AMP/cascade of reactions	no second messenger <b>OR</b> bind to protein/gene activator ✓			
	c.	act at enzyme level	act at gene level ✓			
	d.	both regulate enzyme action ✓				

21.	a	i	Kupffer cell ✓		1
	a	ii	a. they are macrophages/phagocytes ✓ b. break down red blood cells ✓ c. separates heme «group» from «protein» globin chain ✓	<i>There is no ECF here.</i>	2
	b		a. storage of glucose as glycogen <b>OR</b> breakdown of glycogen to glucose ✓ b. deamination/breakdown of «excess» amino acids ✓ c. storage/recycling of iron/copper ✓ d. produces/eliminates cholesterol «as necessary» ✓ e. storage of vitamin A/vitamin D/vitamin B12/vitamin K ✓	<i>Do not accept "sugar".</i>	3 max

Question		Answers	Notes	Total
	<b>c</b>	a. «jaundice is» a yellowish pigmentation of the skin/whites of eyes ✓ b. caused by high levels of bilirubin in blood/tissues ✓ c. comes from breakdown of red blood cells ✓ d. results from the breakdown of the heme group of hemoglobin ✓ e. released into blood when excess produced ✓ f. released into blood when bile ducts blocked ✓ g. normally excreted with bile ✓ h. jaundice is often seen in liver disease such as hepatitis/liver cancer/chronic alcoholism/cirrhosis <b>OR</b> newborn/neonatal jaundice «due to immature liver» ✓		<b>4 max</b>
<b>22.</b>	<b>a</b>	a. determining time of 1 beat = 0.46 «seconds» ✓ b. correct calculation of heart rate/beats per minute = 130 «bpm» ✓	Other possible calculations eg: $23 \text{ «squares»} \times 0.02 \text{ «sec»} = 0.46$ <b>OR</b> $2.3 \times 0.2 \text{ «sec»} = 0.46$ <b>OR</b> $\frac{60 \text{ «sec»}}{0.46 \text{ «sec»}} \text{ «} = 130 \text{»} .$	<b>2</b>
	<b>b</b>	atrial depolarization/electrical impulse travels from the sinoatrial/SA node to the atrioventricular/AV node ✓	Accept atrial systole.	<b>1</b>

Question		Answers	Notes	Total
	<b>c</b>	<p>a. atrium has a small contraction requiring low electrical charge/OWTTE ✓</p> <p>b. the QRS complex shows the depolarization of the «right and left» ventricles ✓</p> <p>c. the ventricles have a large muscle mass compared to the atria, so the QRS complex has a larger amplitude than the P wave/OWTTE</p> <p><b>OR</b></p> <p>ventricle contraction needs more electricity than atrial contraction/OWTTE ✓</p>	<p><i>Accept ventricular systole.</i></p> <p><i>Accept answers implying large muscle mass eg, stronger contraction, more pressure, etc.</i></p>	<b>2 max</b>

Question	Answers	Notes	Total
23.	<p><i>How hemoglobin supplies oxygen to respiring tissues</i></p> <p>a. properly labelled axes showing % saturation hemoglobin and partial pressure of oxygen ✓</p> <p>b. correct/sigmoid shape of «normal» oxygen dissociation curve ✓</p> <p>c. tissues use O<sub>2</sub> for «cellular» respiration thus lowering pO<sub>2</sub> at tissue level <b>OR</b> respiring tissues produce CO<sub>2</sub> ✓</p> <p>d. O<sub>2</sub> dissociates more at lower pO<sub>2</sub> from Hb «than at higher pO<sub>2</sub>» thus providing O<sub>2</sub> to «respiring» tissues/OWTTE ✓</p> <p><i>How Bohr shift increases the supply</i></p> <p>e. CO<sub>2</sub> is converted to hydrogen carbonate ions/HCO<sub>3</sub><sup>-</sup> and H<sup>+</sup> ✓</p> <p>f. increase in H<sup>+</sup> lowers blood pH ✓</p> <p>g. H<sup>+</sup> combines with Hb / conformational change in Hb «in red blood cell» freeing some O<sub>2</sub> ✓</p> <p>h. shifts the oxygen dissociation curve to the right «Bohr shift» <b>OR</b> shift to the right shown on diagram labelled Bohr shift ✓</p> <p>i. oxygen dissociation curve steeper at lower pO<sub>2</sub> «corresponding to respiring tissues» ✓</p>	<p><i>Accept any of the marking points in a clearly annotated diagram. Values not required.</i></p> <p><i>Do not accept concave curves. Curve should start at origin.</i></p>	6 max

Question	Answers	Notes	Total																					
	<p>j. lowers the affinity of hemoglobin for oxygen ✓</p> <p>k. means less oxygen can be carried for same <math>pO_2</math> «as normal» <b>OR</b> «even» more oxygen available for respiring tissues for same <math>pO_2</math> ✓</p> <p>eg:</p>  <table border="1"><caption>Approximate data points from the hemoglobin saturation graph</caption><thead><tr><th>Pressure of oxygen (mmHg)</th><th>Oxygen saturation (%) - Normal pH</th><th>Oxygen saturation (%) - Low pH</th></tr></thead><tbody><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>20</td><td>20</td><td>15</td></tr><tr><td>40</td><td>50</td><td>35</td></tr><tr><td>60</td><td>80</td><td>65</td></tr><tr><td>80</td><td>90</td><td>85</td></tr><tr><td>100</td><td>95</td><td>95</td></tr></tbody></table>	Pressure of oxygen (mmHg)	Oxygen saturation (%) - Normal pH	Oxygen saturation (%) - Low pH	0	0	0	20	20	15	40	50	35	60	80	65	80	90	85	100	95	95		
Pressure of oxygen (mmHg)	Oxygen saturation (%) - Normal pH	Oxygen saturation (%) - Low pH																						
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