

# Markscheme

**May 2017**

**Biology**

**Higher level**

**Paper 2**

18 pages

This markscheme is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of the IB Global Centre, Cardiff.

**Section A**

Question		Answers	Notes	Total																			
		<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">Mouth</th> <th colspan="2">Kidney</th> </tr> <tr> <th>In water</th> <th>Out</th> <th>In water</th> <th>Out</th> </tr> </thead> <tbody> <tr> <td>Ammonia</td> <td>0.29</td> <td>0.30</td> <td>0.63</td> <td>0.54</td> </tr> <tr> <td>Urea</td> <td>0.90</td> <td>1.56</td> <td>0.07</td> <td>0.73</td> </tr> </tbody> </table>		Mouth		Kidney		In water	Out	In water	Out	Ammonia	0.29	0.30	0.63	0.54	Urea	0.90	1.56	0.07	0.73		
	Mouth			Kidney																			
	In water	Out	In water	Out																			
Ammonia	0.29	0.30	0.63	0.54																			
Urea	0.90	1.56	0.07	0.73																			
<b>1.</b>	<b>a</b>	<p>a. urea ✓</p> <p>b. for both mouth and kidney ✓</p> <p>c. percentage change/change in <math>\mu\text{mol day}^{-1} \text{g}^{-1}</math> greater with urea/other acceptable numerical comparison ✓</p>		<b>2</b>																			
	<b>b</b>	<p>a. both higher/increased on emergence from/with turtle out of water ✓</p> <p>b. both increased by <u>0.66</u> «<math>\mu\text{mol}^{-1} \text{g}^{-1}</math> when turtle emerges from water» ✓</p> <p>c. % increase is higher in kidney / kidney 940% versus mouth 73/75% / increase is higher proportionately higher in kidney / kidney x10 versus mouth nearly double/x1.73 ✓</p> <p>d. urea excretion by mouth greater than kidney out of water «despite larger % increase in kidney excretion» ✓</p>		<b>3</b>																			

Question		Answers	Notes	Total
<b>c</b>	<b>i</b>	decrease «when head is submerged» <u>and</u> increase when head is out of water ✓		<b>1</b>
	<b>ii</b>	a. oxygen absorbed from water/exchanged for urea when head dipped in water «so oxygen concentration decreases» ✓ b. lungs cannot be used with head in water / can «only» be used with head out of water ✓ c. oxygen from water «in mouth» used in «aerobic cell» <u>respiration</u> ✓ d. oxygen from air dissolves in water when head out of water «so oxygen concentration increases» ✓		<b>2 max</b>
<b>d</b>		a. urea transporter is present ✓ b. less urea «excreted»/ lower rate «of urea excretion» / excretion almost zero when phloretin/inhibitor was present ✓		<b>2</b>

Question		Answers	Notes	Total
1.	e	<p>a. <u>mRNA</u> only in mouth and tongue/in mouth and tongue but not esophagus intestine kidney or bladder ✓</p> <p>b. <u>bands</u> / <u>lines</u> indicate mRNA for/expression of urea transporter gene ✓</p> <p>c. <u>urea transporter gene</u> expressed / <u>urea transporters</u> in mouth/tongue / not expressed/made in esophagus/intestine/kidneys/bladder ✓</p> <p>d. mRNA/transcription/gene expression/urea transporters higher in <u>tongue</u>/more in <u>tongue</u> «than mouth»✓</p>		2 max
	f	i	<p>salt solution is control because it does not contain a nitrogenous/excretory waste product / it matches the salt concentration of the turtle / the turtle's body already contains salt / because the turtle lives in salt water/salt marshes / because nothing has been altered ✓</p>	1
		ii	<p>a. ammonia is «highly» toxic/harmful ✓</p> <p>b. ammonia is more toxic than urea/converse ✓</p> <p>c. ammonia converted to urea ✓</p> <p>d. urea concentration raised «by injecting ammonia» ✓</p> <p>e. difference between ammonia and urea «possibly» not «statistically» significant ✓</p>	2 max

Question	Answers	Notes	Total
g	<p><i>Problems:</i></p> <ul style="list-style-type: none"> <li>a. urea becomes more concentrated «in small pools» / lower concentration gradient «between tongue/mouth and water» ✓</li> <li>b. less water available for urine production/excretion by kidney</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>less water in ponds for mouth rinsing/more competition for pools (to use for mouth rinsing) ✓</li> </ul> <p><i>Behaviour to overcome problems:</i></p> <ul style="list-style-type: none"> <li>c. «still able to» dip mouth into/mouth rinse in water/pools ✓</li> <li>d. «still able to» excrete urea «through the mouth» in the small pools ✓</li> <li>e. more conversion of ammonia to urea/urea excretion rather than ammonia ✓</li> <li>f. more urea transporters/expression of urea transporter gene ✓</li> <li>g. urea excreted «in mouth/via microvilli» by active transport/using ATP ✓</li> <li>h. excretion with little/no loss of water ✓</li> </ul>		<b>3 max</b>

Question			Answers	Notes	Total
2.	a	i	DNA <u>and</u> histone ✓		1
		ii	methylation/acetylation/phosphorylation/epigenetic tags/modification of nucleosome tails/N-terminal tails ✓		1
	b		a. binding/carrying/transporting amino acid/amino acids / to hold the polypeptide chain «during translation» ✓ b. anticodon / to bind with a codon «on mRNA» / to translate mRNA ✓		2
	c		a. «proteins from free ribosomes remain/are used in the» <u>cytoplasm/cell</u> ✓ b. «proteins from bound ribosomes» pass into ER/Golgi apparatus/lysosomes / are secreted/pass out of cell / «are used» outside cell ✓		2

Question		Answers	Notes	Total	
3.	a	<p>a. spontaneous generation is life appearing from nothing/from non-living/cells only come from pre-existing cells/life ✓</p> <p>b. broth/culture medium «for bacteria» «used/placed» in flasks ✓</p> <p>c. broth boiled/sterilized «in some flasks» to kill microbes ✓</p> <p>d. no clouding/signs of bacteria growth/reproduction/microbes did not appear «in flasks of boiled broth» ✓</p> <p>e. after necks of flasks snapped boiled broth became cloudy/growth «of microbes» ✓</p> <p>f. because microbes from the air contaminated the «boiled» broth ✓</p> <p>g. curved necks allowed exposure to air but prevented entry of microbes ✓</p>	<p><i>Allow bacteria or organisms instead of microbes.</i></p>	3 max	
	b	i	<p>movement / locomotion <b>OR</b> feeding/nutrition ✓</p>	<p><i>If student has multiple answers do not accept the second answer if the first one is incorrect.</i></p>	1
		ii	<p>homeostasis <b>OR</b> maintain osmotic balance / osmoregulation / expels «excess» water / maintains «cell» water content ✓</p>	<p><i>If student has multiple answers do not accept the second answer if the first one is incorrect.</i></p>	1



Question	Answers	Notes	Total
<p><b>c</b></p>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>a. «adult stem cells» can divide «endlessly» / can differentiate ✓</li> <li>b. «adult stem cells» can be used to repair/regenerate «tissues» ✓</li> <li>c. fewer ethical objections «than with embryonic stem cells» ✓</li> <li>d. adult source not killed / «source» would not have grown into new human / no death of embryos used to provide stem cells ✓</li> <li>e. adults can give «informed» consent for use of their stem cells ✓</li> <li>f. no rejection problems / patient’s own cells used ✓</li> <li>g. less chance of cancer/«malignant» tumor development «than with embryonic stem cells»</li> <li>h. most tissues in adults contain some stem cells ✓</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>i. difficult to obtain/collect/find in adult body/; ✓</li> <li>j. some «adult» tissues contain few/no stem cells/very few available ✓</li> <li>k. (adult stem cells) differentiate into fewer cell types «than embryonic cells»/WTTE ✓</li> </ul>	<p><i>Maximum [2] if only advantages or only disadvantages are included.</i></p>	<p><b>3 max</b></p>

Question		Answers	Notes	Total
4.	a	increases the greenhouse effect/global warming/temperatures «on Earth» ✓		1
	b	a. organisms/community plus the environment / biotic and abiotic «components» ✓ b. interactions ✓ c. ecosystems show sustainability ✓ d. nutrients are recycled in ecosystems ✓ e. energy flows through ecosystems ✓ f. producers «are part of all ecosystems» ✓ g. decomposers/saprotrophs «are part of all ecosystems» ✓		2 max

Question		Answers	Notes	Total
c	i	a. active transport/pumps used to load sugars/sucrose into phloem/companion cells/sieve tubes ✓ b. loading in sources/unloading in sinks <b>OR</b> sucrose/sugars moved from source to sink ✓ c. active transport moves H <sup>+</sup> out of phloem/sieve tubes «to make H <sup>+</sup> gradient in the leaf/source» ✓ d. H <sup>+</sup> gradient used for co-transport of sucrose into phloem/sieve tubes/companion cells ✓	Accept protons or hydrogen ions instead of H <sup>+</sup> ions.  Accept the equivalent of mpc and mpd for unloading in the sink.	2 max
	ii	a. transpiration/evaporation of water causes suction/tension ✓ b. water sucked/drawn out of <u>xylem</u> «in leaf» ✓ c. water moves up in xylem ✓ d. due to suction/tension/pulling forces ✓ e. cohesion of water/hydrogen bonds between water molecules ✓ f. movement from roots to leaves ✓ g. water enters root by osmosis/due to higher solute concentration inside root ✓		3 max

**Section B**

**Clarity of communication: [1]**

*The candidate's answers are clear enough to be understood without re-reading. The candidate has answered the question succinctly with little or no repetition or irrelevant material.*

Question		Answers	Notes	Total
5.	a	a. NAD/FAD carries/is reduced by gaining «two» H «atoms»/«two» electrons ✓ b. reduced NAD produced in glycolysis/link reaction/Krebs cycle ✓ c. reduced NAD/FAD delivers electrons/hydrogen «atoms» to ETC ✓ d. ETC is in mitochondrial inner membrane/cristae ✓ e. electrons release energy as they flow along the chain/from carrier to carrier ✓ f. electrons from ETC accepted by oxygen/oxygen is the final electron acceptor ✓ g. proteins in the inner mitochondrial membrane/electron carriers act as proton pumps ✓ h. protons pumped into intermembrane space/proton gradient across inner mitochondrial membrane/proton concentration higher in intermembrane space than in matrix ✓ i. energy «from electrons» used to pump protons into intermembrane space/generate a proton gradient / high H <sup>+</sup> concentration is a store of «potential» energy ✓ j. ATP synthase in inner mitochondrial membrane/cristae ✓ k. energy released as protons pass down the gradient/through ATP synthase ✓ l. ATP synthase converts ADP to ATP/phosphorylates ADP ✓ m. oxidative phosphorylation «is ATP production using energy from oxidizing foods» ✓	<p><i>Accept H<sup>+</sup> but not H/hydrogen in place of protons in any part of the answer.</i></p> <p><i>Accept NADH or FADH in place of reduced NAD or FAD.</i></p>	<b>8 max</b>

Question		Answers	Notes	Total
5.	b	a. receptor/binding site for <u>hormone/neurotransmitter</u> ✓ b. cell-to-cell communication / cell recognition ✓ c. channels «for passive transport» / facilitated diffusion ✓ d. pumps / active transport ✓ e. cell adhesion ✓ f. «immobilized» enzymes/enzymes embedded in the membrane ✓ g. electron transport / electron carriers ✓		4 max
	c	a. metabolism is all <u>enzyme-catalyzed</u> reactions in a cell/organism/is <u>anabolism</u> plus <u>catabolism</u> ✓ b. anabolism is synthesis of polymers/complex/larger molecules/larger substances «from smaller molecules/monomers» ✓ c. catabolism is breaking down «complex» molecules/substances «into simpler/smaller ones/into monomers» ✓		3 max

Question		Answers	Notes	Total
6.	a	a. «immumoglobulins are/function as» <u>antibodies</u> ✓ b. variety of binding sites / variable regions for binding ✓ c. <u>specific</u> to antigens on bacteria/viruses/pathogens ✓ d. constant region aids destruction of the bacteria/virus/pathogen ✓ e. attracts phagocytes/macrophages to engulf pathogen ✓ f. bursting pathogen cells/agglutination/neutralizing toxins/other example of the action of antibodies ✓	<i>Award marks for an annotated diagram.</i>	<b>3 max</b>
	b	a. protect against/kill/inhibit growth of microorganisms/bacteria/prokaryotes ✓ b. bacteria/prokaryote processes blocked but not processes in eukaryotes/other organisms ✓ c. block metabolic pathways/DNA replication/DNA transcription/translation/ribosome functioning/cell wall formation ✓ d. do not protect against viruses as they have no metabolism/are non-living ✓ e. antibiotics fail to protect if bacteria have resistance ✓ f. can be used in humans/animals because antibiotics do not affect eukaryotic cells/bacterial metabolism is different ✓		<b>4 max</b>

Question		Answers	Notes	Total
6.	c	<p>a. <u>myofibrils</u> «in muscle fibers/cells» ✓</p> <p>b. <u>sarcomeres</u> «are the repeating units in muscle/myofibrils» ✓</p> <p>c. <u>sarcomeres</u> arranged end to end / <u>sarcomeres</u> shorten during muscle contraction ✓</p> <p>d. actin and myosin/overlapping protein filaments/diagram to show sarcomere with actin and myosin overlapping ✓</p> <p>e. dark and light bands «in sarcomeres»/diagram to show this/light bands narrower when muscle is contracted ✓</p> <p>f. thick filament is myosin and thin filament is actin/diagram to show this ✓</p> <p>g. nerve impulses stimulate contraction/cause depolarization of sarcolemma/T-tubules/trigger release of calcium from sarcoplasmic reticulum ✓</p> <p>h. calcium ions released from sarcoplasmic reticulum/bind to troponin ✓</p> <p>i. <u>troponin</u> causes tropomyosin to move/exposes binding sites on actin ✓</p> <p>j. myosin «heads» form cross bridges with/bind to actin ✓</p> <p>k. <u>myosin heads</u> move/change angle/swivel/cock / <u>myosin heads</u> cause the power stroke ✓</p> <p>l. myosin filaments pull actin towards center of sarcomere/more overlap between actin and myosin/Z-lines move closer ✓</p> <p>m. <u>ATP</u> is used «to provide energy»/cause cross-bridges to break/cause movement of myosin heads/cause filaments to slide/cause muscle contraction ✓</p> <p>n. intercostal/abdominal/diaphragm muscles contract «to cough» ✓</p>	<p><i>Marks can be awarded for any point made clearly on an annotated diagram.</i></p>	<p><b>8 max</b></p>

Question		Answers	Notes	Total
7.	a	<p><i>Genes</i></p> <p>a. <u>mutation</u> changes genes/causes genetic differences ✓</p> <p>b. genes can have more than one <u>allele</u>/multiple <u>alleles</u>  <b>OR</b>  <u>alleles</u> are different forms/versions of a gene ✓</p> <p>c. different <u>alleles</u> «of a gene» give different characters  <b>OR</b>  variation in <u>alleles</u> between individuals ✓</p> <p>d. eye colour/other example of «alleles of» a gene affecting a character ✓</p> <p>e. <u>alleles</u> may be <u>dominant</u> or <u>recessive</u>  <b>OR</b>  <u>dominant alleles</u> determine trait even if <u>recessive allele</u> is present ✓</p> <p>f. both alleles influence the characteristic with codominance  <b>OR</b>  reference to polygenic inheritance ✓</p> <p>g. all members of a species are genetically similar/have shared genes  <b>OR</b>  certain genes expressed in all members of a species ✓</p> <p>h. reference to epigenetics/methylation/acetylation / not all genes are expressed  «in an individual» ✓</p> <p>i. genes are inherited from parents/passed on to offspring/passed from generation to generation ✓</p>		7 max

(continued...)



(Question 7a continued)

Question		Answers	Notes	Total
7	a	<p><i>Chromosomes</i></p> <p>j. same locus/same position of genes <b>OR</b> same sequence of genes/same genes on each chromosome «in a species» ✓</p> <p>k. same number of chromosomes «in a species»/all humans have 46 chromosomes/differences in chromosome number between species ✓</p> <p>l. some individuals have an extra chromosome/Down syndrome/other example of aneuploidy <b>OR</b> polyploidy divides a species/creates a new species ✓</p> <p>m. X and Y/sex chromosomes determine the sex/gender of an individual ✓</p> <p>n. meiosis/independent assortment/fertilization/sexual reproduction give new combinations «of chromosomes/genes» ✓</p>		

Question		Answers	Notes	Total
7.	b	a. speciation is the splitting of a species «into two species» ✓ b. reproductive isolation/lack of interbreeding ✓ c. isolation due to geography/«reproductive» behavior/«reproductive» timing ✓ d. polyploidy can cause isolation ✓ e. gene pools separated ✓ f. differences in/disruptive selection cause traits/gene pools to change/diverge ✓ g. gradualism / speciation/changes accumulating over long periods ✓ h. punctuated equilibrium / speciation/changes over a short time period ✓		4 max
	c	a. similar structure but different function «in homologous structures» ✓ b. pentadactyl limbs/limb with five digits/toes / other example ✓ c. similar bone structure/example of similarity of bones «in pentadactyl limbs» but different uses/functions ✓ d. two examples of use of pentadactyl limb by a vertebrate group ✓ e. suggests a common ancestor «and evolutionary divergence» ✓ f. process called adaptive radiation ✓		4 max