

Biology
Higher level
Paper 2

Wednesday 15 November 2017 (afternoon)

Candidate session number

2 hours 15 minutes

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Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer two questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[72 marks]**.



Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Hypoxia is a condition in which tissues of the body are deprived of an adequate oxygen supply. A study was carried out in rats to examine the effects of continuing hypoxia on the structure of the diaphragm, and to determine whether nitric oxide is implicated in adaptation of the diaphragm to hypoxia. The diaphragm helps to supply oxygen to tissues and organs in the body by ventilating the lungs.

A group of 36 adult male rats were kept for 6 weeks in low oxygen while 36 adult male rats were kept in normal oxygen levels.

		Body mass / g	Erythrocytes / % of total blood volume	Mass of right ventricle muscle / mg
1 week	Control	305.7 ± 7.4	39.3 ± 1.7	154.3 ± 7.4
	Hypoxia	*238.3 ± 5.0	*62.6 ± 1.9	*194.8 ± 8.9
2 weeks	Control	302.3 ± 5.0	39.6 ± 1.1	157.8 ± 3.4
	Hypoxia	*229.7 ± 4.6	*70.1 ± 1.0	*204.7 ± 11.2
3 weeks	Control	325.0 ± 10.3	45.0 ± 0.7	166.8 ± 3.6
	Hypoxia	*255.0 ± 8.3	*71.3 ± 1.0	*238.7 ± 18.9
6 weeks	Control	369.8 ± 5.9	43.0 ± 2.6	164.7 ± 3.9
	Hypoxia	*277.5 ± 7.9	*75.1 ± 1.4	*251.3 ± 8.0

Key: * indicates significant difference from corresponding control value (student's *t*-test, *p* < 0.05)

[Source: Reproduced with permission of the © ERS 2011. *European Respiratory Journal* June 2011, 37 (6) 1474–1481; DOI: 10.1183/09031936.00079810]

- (a) Outline the effect of hypoxia on body mass and erythrocyte percentage.

[1]

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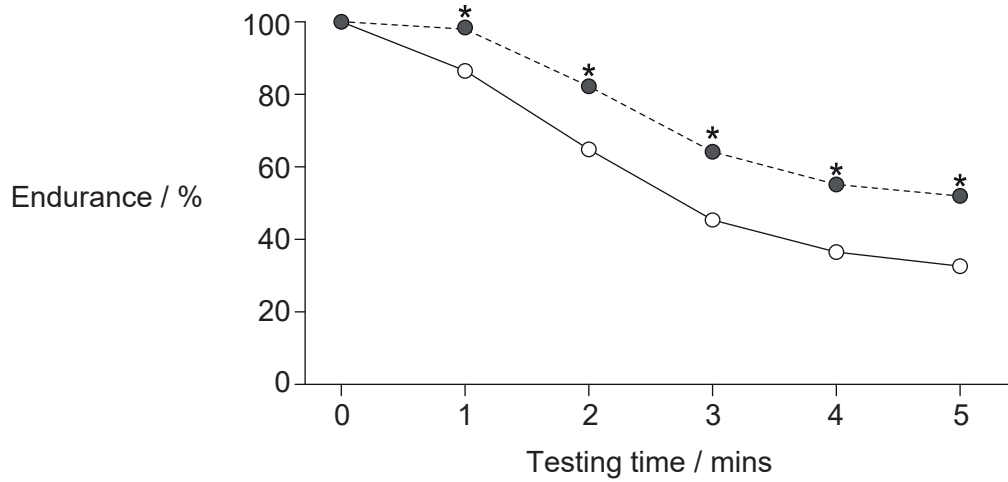
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(Question 1 continued)

(b) The graph shows the effect of hypoxia on the endurance of rats' diaphragm muscle after 6 weeks. Endurance is the change in force measured as a percentage of the initial force.



Key: * indicates significant difference from control ($p < 0.0001$)
--●-- hypoxia
—○— control

[Source: Reproduced with permission of the © ERS 2011. *European Respiratory Journal* June 2011, 37 (6) 1474–1481; DOI: 10.1183/09031936.00079810]

Using the data in the graph, deduce whether hypoxia increases or decreases the endurance of the rats' diaphragm muscle. [2]

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(c) Using the data so far presented in this question, explain the effect of hypoxia on the body. [2]

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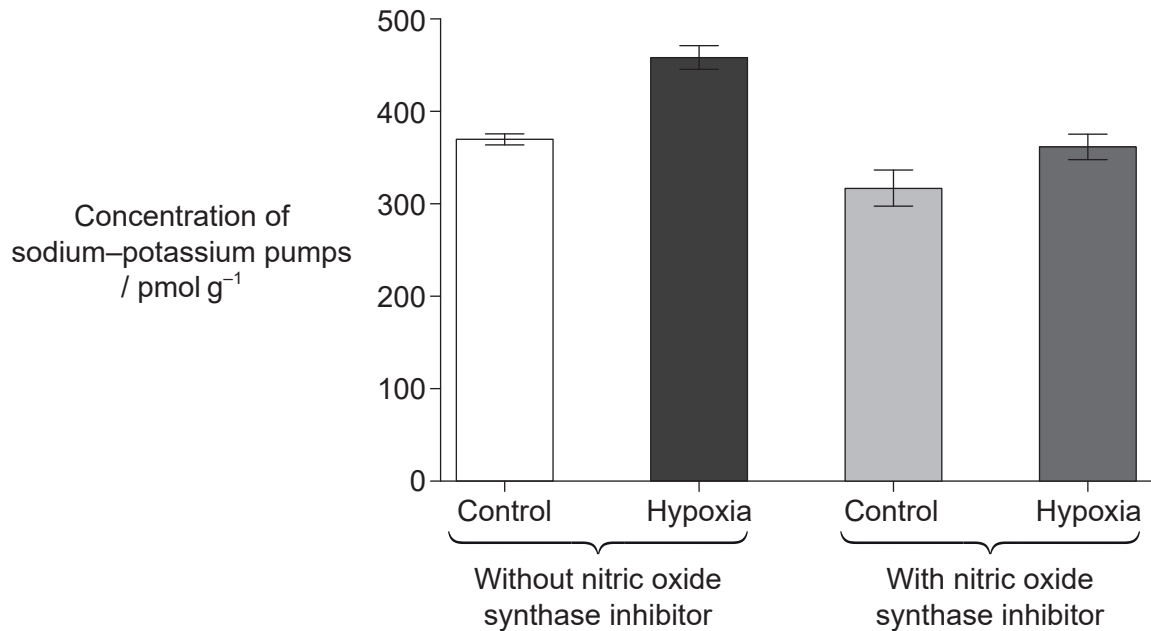


16EP03

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(Question 1 continued)

- (d) The sodium–potassium pump plays a role in muscle activity. Nitric oxide may have a role in the recovery of hypoxic muscles. The production of nitric oxide can be blocked with an inhibitor of the enzyme nitric oxide synthase. The graph shows the concentration of sodium–potassium pumps in the diaphragm of control and hypoxic rats without and with nitric oxide synthase inhibitor.



[Source: Reproduced with permission of the © ERS 2011. *European Respiratory Journal* June 2011, 37 (6) 1474–1481; DOI: 10.1183/09031936.00079810]

- (i) Analyse the graph to obtain **two** conclusions about the concentration of sodium–potassium pumps.

[2]

1.

2.

(This question continues on the following page)



(Question 1 continued)

- (ii) Muscle fibres are stimulated to contract by the binding of acetylcholine to receptors in their membranes and the subsequent depolarization. Suggest a reason for increasing the concentration of sodium–potassium pumps in the membranes of diaphragm muscle fibres. [1]

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- (e) Skeletal muscle contractions can take two different forms: if they are stimulated by a single action potential they take the form of a twitch and if they are stimulated by a series of action potentials the contraction is longer lasting (tetanic). The table shows the effects of hypoxia on the force of twitch and peak tetanic contraction in the diaphragm.

		Twitch contraction / N cm⁻²	Peak tetanic contraction / N cm⁻²
Diaphragm	Control	4.0 ± 0.7	20.0 ± 2.3
	Hypoxia	2.8 ± 0.4	14.2 ± 1.8

[Source: Reproduced with permission of the © ERS 2011. *European Respiratory Journal* June 2011, 37 (6) 1474–1481; DOI: 10.1183/09031936.00079810]

- (i) Outline the effect of hypoxia on the force of contraction of the diaphragm. [1]

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- (ii) Hypoxia caused a 13% increase in the surface area to volume ratio of the diaphragm. Suggest a reason for this change. [1]

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(Question 1 continued)

- (f) Using all relevant data in the question, evaluate the effectiveness of the rats' adaptation to hypoxia.

[3]

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- (g) Discuss the advantages and disadvantages of using rats as models in this investigation.

[2]

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2. The figure shows a transmission electron micrograph of rotavirus particles. Each rotavirus is about 70 nanometres in diameter.



[Source: CDC / Dr. Erskine L. Palmer]

- (a) State a reason for using an electron microscope to view this virus rather than a light microscope.

[1]

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- (b) Rotavirus causes diarrhea and vomiting. Explain why viral diseases cannot be treated using antibiotics.

[2]

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- (c) State the role of plasma cells in the immune system.

[1]

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16EP07

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(Question 2 continued)

(d) (i) Describe the production of hybridoma cells.

[2]

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(ii) State **one** possible use of hybridoma cells.

[1]

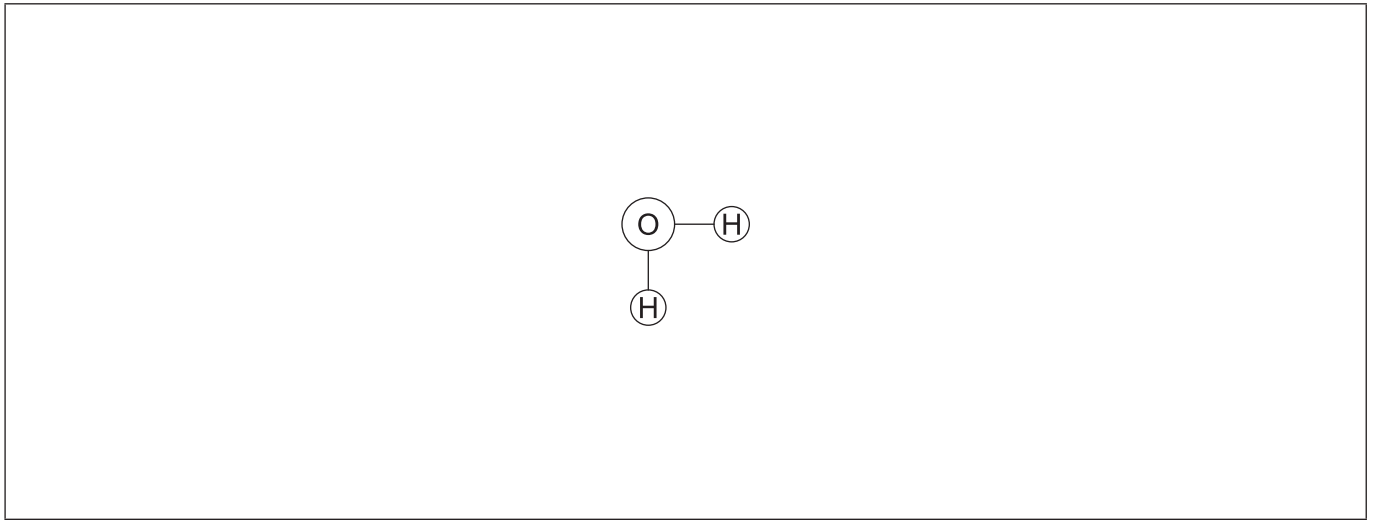
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3. The figure represents a water molecule.



(a) Draw a second water molecule to show how bonds can form between water molecules, including the name of the bond. [2]

(b) Water has important solvent properties. Explain these properties using an example to illustrate your answer. [3]

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(c) Describe the role of ADH in human osmoregulation. [3]

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4. The diagram shows a leaf from *Dryopteris arguta*.



[[https://commons.wikimedia.org/wiki/File:E20161208-0001%E2%80%94Dryopteris_arguta_\(Reverse\)%E2%80%94RPBG_\(30698925004\).jpg](https://commons.wikimedia.org/wiki/File:E20161208-0001%E2%80%94Dryopteris_arguta_(Reverse)%E2%80%94RPBG_(30698925004).jpg), E20161208-0001—*Dryopteris arguta* (Reverse)—RPBG
Source: https://www.flickr.com/photos/john_d_rusk/30698925004/
Author: John Rusk from Berkeley, CA, United States of America, licensed under Creative Commons licence:
<https://creativecommons.org/licenses/by/4.0/legalcode>]

(a) (i) State the phylum of this plant. [1]

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(ii) State **two** characteristics of plants from the phylum you stated in (a)(i). [2]

1.
2.

(b) Describe the process of photolysis in photosynthesis. [3]

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5. (a) Describe the process of crossing over.

[2]

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(b) Explain the reason for linked genes **not** following the pattern of inheritance discovered by Mendel.

[2]

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Section B

Answer **two** questions. Up to one additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

6. Cell biologists play an important role in research into disease, fertility, evolution and many other areas of science.
- (a) Describe the origin of eukaryotic cells according to the endosymbiotic theory. [4]
 - (b) Compare and contrast the processes of spermatogenesis and oogenesis. [8]
 - (c) Outline the evidence for evolution provided by selective breeding. [3]
7. Nitrogen is part of many important substances in living organisms.
- (a) Draw labelled diagrams to show a condensation reaction between two amino acids. [3]
 - (b) Distinguish between transcription and translation. [4]
 - (c) Explain how insects excrete nitrogenous wastes. [8]
8. Plants have widespread influences, from food chains to climate change.
- (a) Draw a labelled diagram of the internal structure of a seed. [3]
 - (b) Explain the process of water uptake and transport by plants. [8]
 - (c) Describe the process of peat formation. [4]



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16EP13

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16EP15

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