

SINGAPORE'S
#1 HOME TUITION AGENCY

.....○

Need A Home Tutor?

🌐 singaporetuitonteachers.com

☎ +65 9695 3522

Contact Us Today For A 100% Free Tutor Request!

○.....

OUR TEST PAPERS ARE:

- ✓ **COMPLETELY FREE!**
- ✓ **SOURCED FROM TOP SCHOOLS**
- ✓ **HIGH-QUALITY**
- ✓ **USED BY 10,000+ SATISFIED STUDENTS**



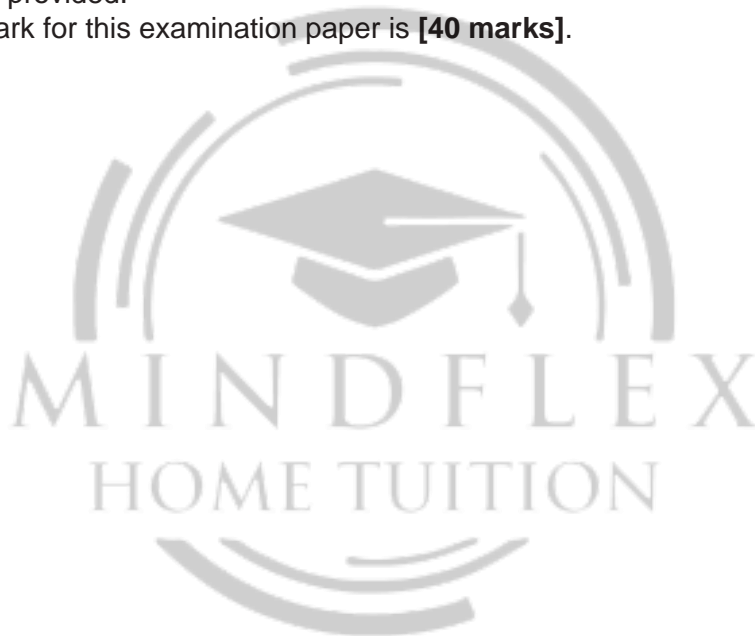
Biology
Higher level
Paper 1

Wednesday 15 November 2017 (afternoon)

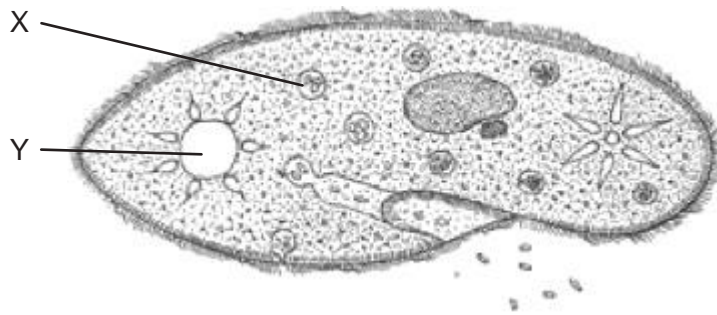
1 hour

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The maximum mark for this examination paper is **[40 marks]**.



The image of a *Paramecium* refers to question 1 and question 2.



[Source: Adapted from www.biology-resources.com. Copyright 2004–2017
D G Mackean & Ian Mackean. All rights reserved.]

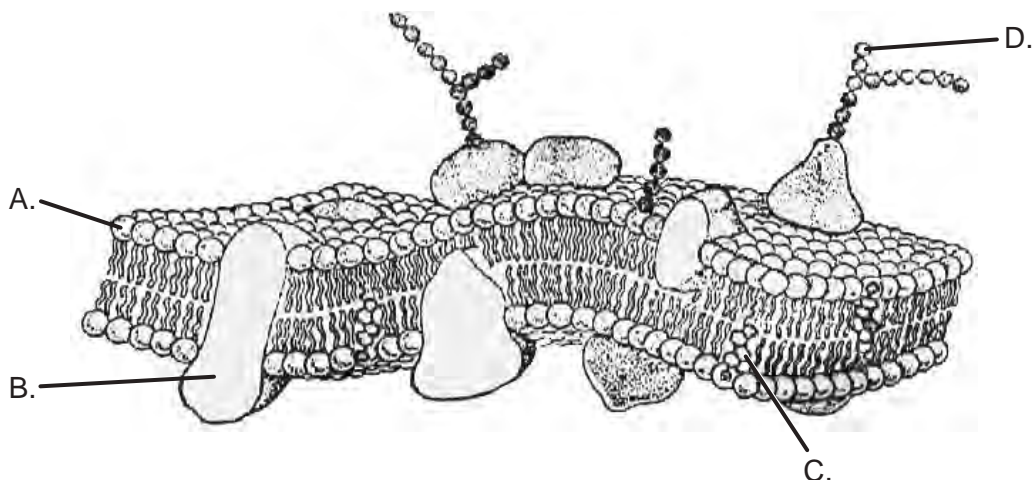
1. Which function is accomplished by structures X and Y in the *Paramecium*?

	X	Y
A.	digestion	homeostasis
B.	feeding	metabolism
C.	food storage	movement
D.	DNA replication	respiration

2. The salt concentration inside the *Paramecium* is 1.8%. The salt concentration in the surrounding medium suddenly drops to 0.2%. What will be the likely response?

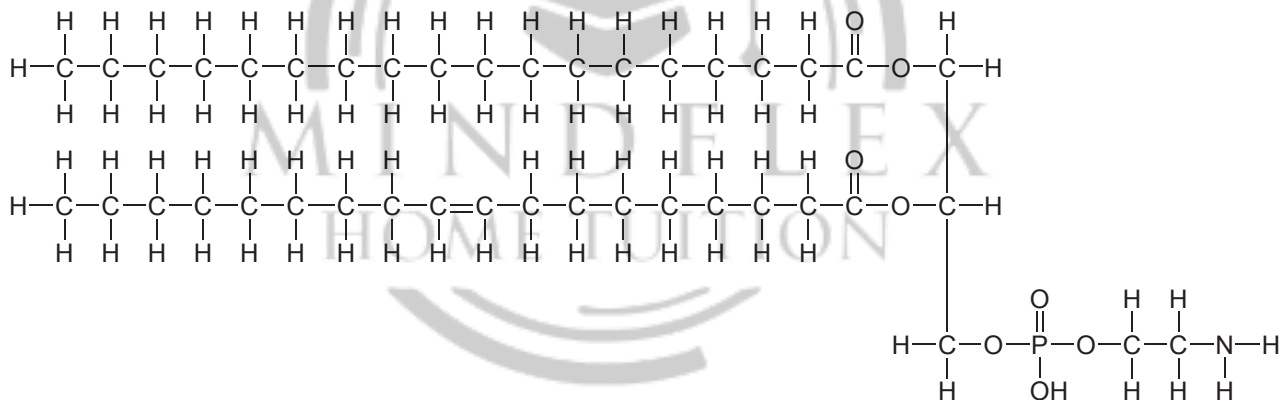
- A. The cell will lose salt to the medium.
- B. The contractile vacuole will expel more water.
- C. The cell will swell and eventually burst.
- D. The membrane will become more permeable to salt.

The diagram of a membrane refers to question 3 and question 4.

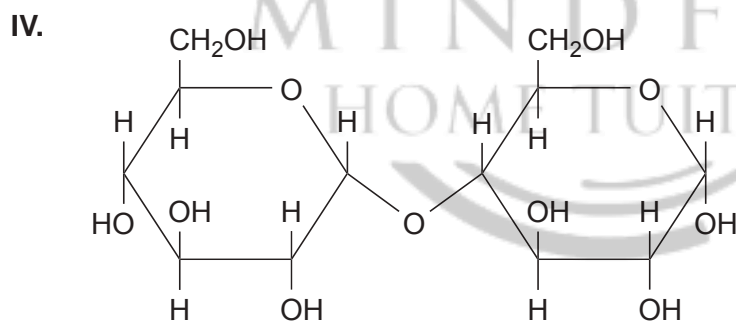
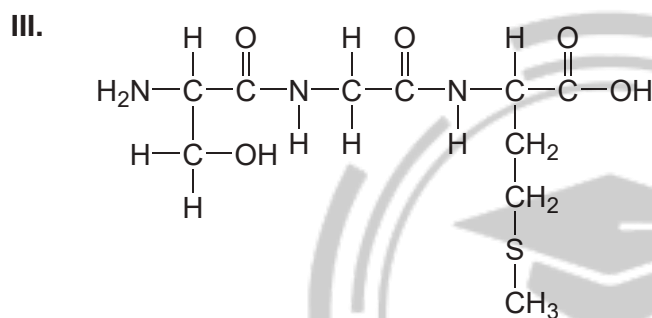
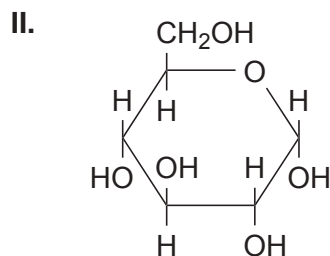
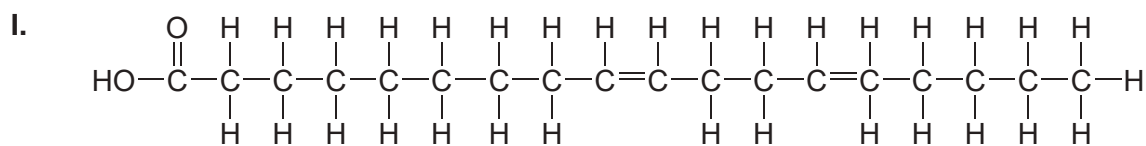


[Source: © International Baccalaureate Organization 2017]

3. In the diagram, which structure is an intrinsic or integral protein?
4. In the diagram, which part of the membrane structure does the molecule below form?

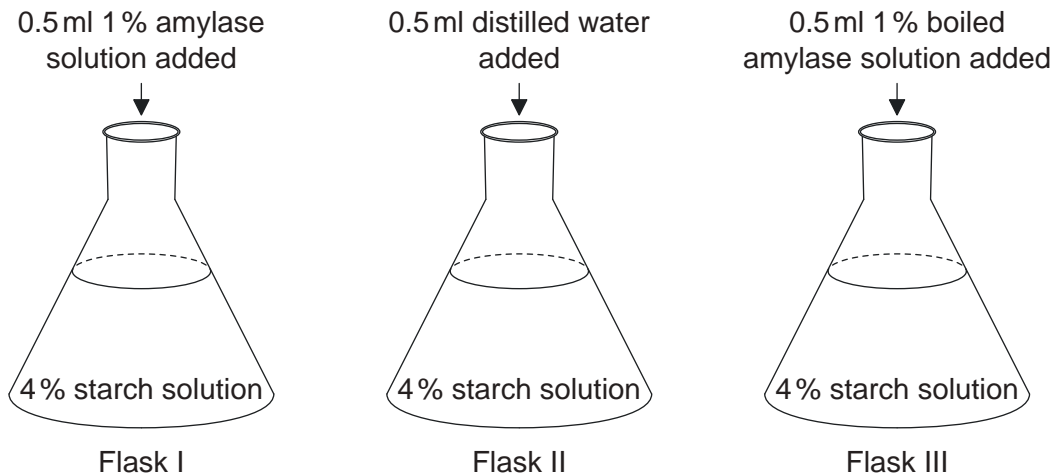


5. Which of the molecules contain peptide bonds or are sugar molecules?



	Contain peptide bonds	Are sugar molecules
A.	I, III	II
B.	III	II, IV
C.	I, III, IV	II
D.	I	III, IV

6. Three flasks were prepared for an analysis of the activity of amylase. At time zero, each of the substances indicated in the diagrams was added.



Which flask(s) could provide support for the hypothesis that heat denatures enzymes?

- A. Flasks I and II after 15 minutes
- B. Flasks II and III after 15 minutes
- C. Flasks I and III after 15 minutes
- D. Flask III at time zero and again after 15 minutes
7. For which discovery about DNA do Watson and Crick receive credit?
- A. DNA is the molecule that genes are made of.
- B. The amount of adenine equals the amount of thymine in an organism.
- C. Phosphate–pentose bonding along the nucleotide backbone is covalent.
- D. The shape of DNA is a double helix.

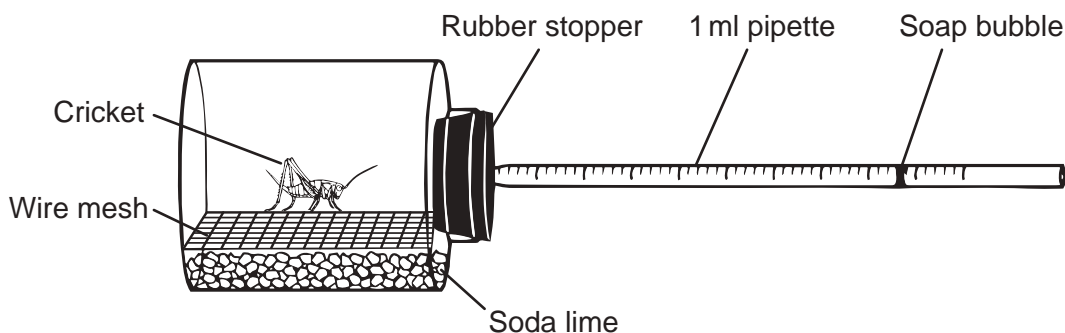
8. Which sequence of bases and amino acids could be produced by transcription and translation of the DNA molecule shown?

3' ATGAAATGCTTTTCGCGGG 5'
5' TACTTTACGAAAGCGCCC 3'

		2nd base in codon				
		U	C	A	G	
1st base in codon	U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	U C A G
	C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G
	A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
	G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G

	Sequence of bases	Sequence of amino acids
A.	UAC-UUU-ACG-AAA-GCG-CCC	Leu-Lys-Cys-Phe-Arg-Gly
B.	GGG-CGC-UUU-CGU-AAA-CAU	Gly-Arg-Phe-Arg-Lys-His
C.	AUC-AAA-UGC-UUU-CGC-GGG	Met-Lys-Cys-Phe-Arg-Gly
D.	UAC-UUU-ACG-AAA-GCG-CCC	Tyr-Phe-Thr-Lys-Ala-Pro

9. A cricket was placed in a respirometer at constant temperature for ten minutes. The soap bubble moved along the pipette.



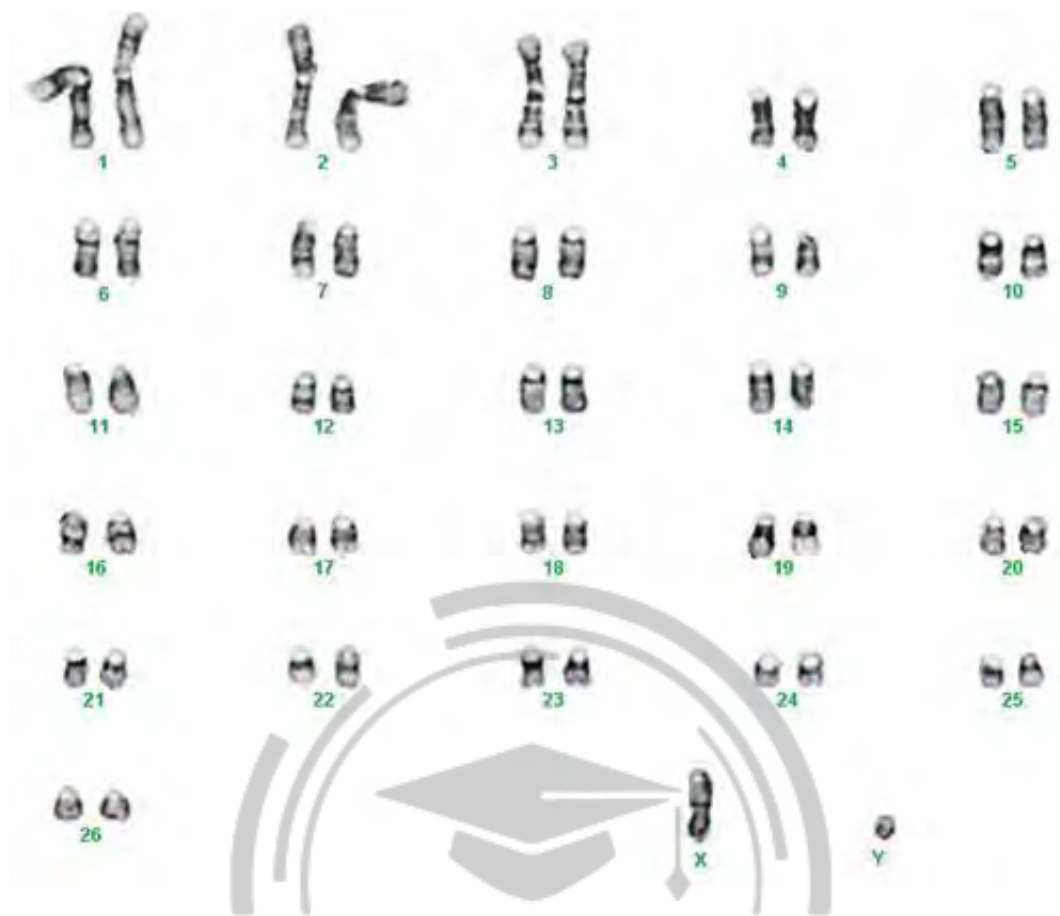
[Source: © International Baccalaureate Organization 2017]

What was measured by the movement of the soap bubble?

- A. Production of carbon dioxide
- B. Volume of excretory products
- C. Oxygen consumption
- D. Release of heat



10. The image shows a karyogram.

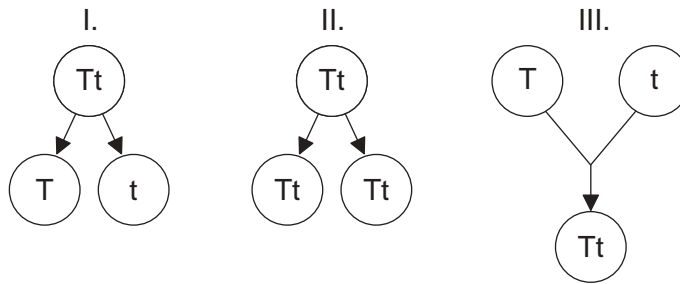


[Source: [https://commons.wikimedia.org/wiki/File:Karyotype_of_sheep_\(Ovis_aries\).png](https://commons.wikimedia.org/wiki/File:Karyotype_of_sheep_(Ovis_aries).png),
by M. Singh, X. Ma, E. Amoah and G. Kannan]

What information can be determined from this karyogram?

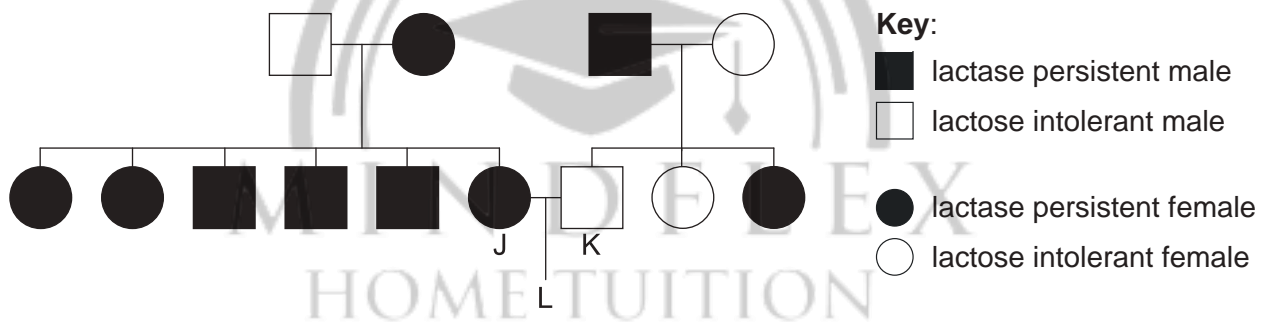
- A. The sex is female.
- B. The haploid number is 54.
- C. Disjunction occurred during meiosis.
- D. The species is not human.

11. Which diagram(s) represent(s) processes used in asexual reproduction?



- A. I only
- B. I and II only
- C. II only
- D. I, II and III

12. A dominant autosomal allele for lactase persistence allows humans to digest milk as adults. People who lack this allele are lactose intolerant in adulthood.



If J and K have a child L, what is the probability that L will be lactase persistent?

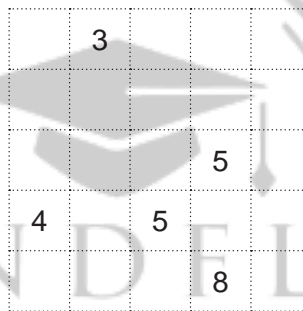
- A. 25%
- B. 50%
- C. 75%
- D. 100%

13. *HindIII* is an endonuclease that recognizes the sequence AAGCTT, cutting between the two adenines.



Into how many DNA fragments would the strand shown be cut by *HindIII*?

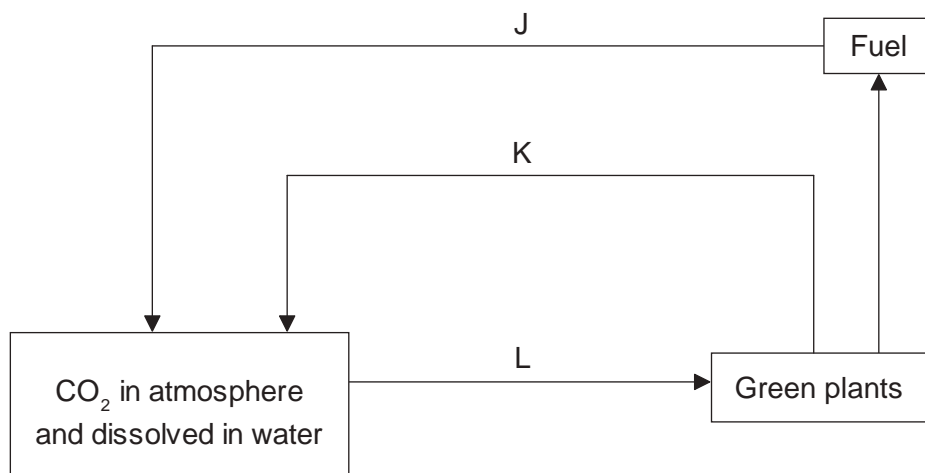
- A. 2
B. 3
C. 4
D. 5
14. In an area of forest measuring 100 m by 100 m, samples were taken to estimate the number of silver maple (*Acer saccharinum*) trees in the forest. The number of trees counted in each of five areas of 400 m² was recorded.



Approximately how many silver maple trees are in the 10000m² area of forest?

- A. 5
B. 25
C. 125
D. 625

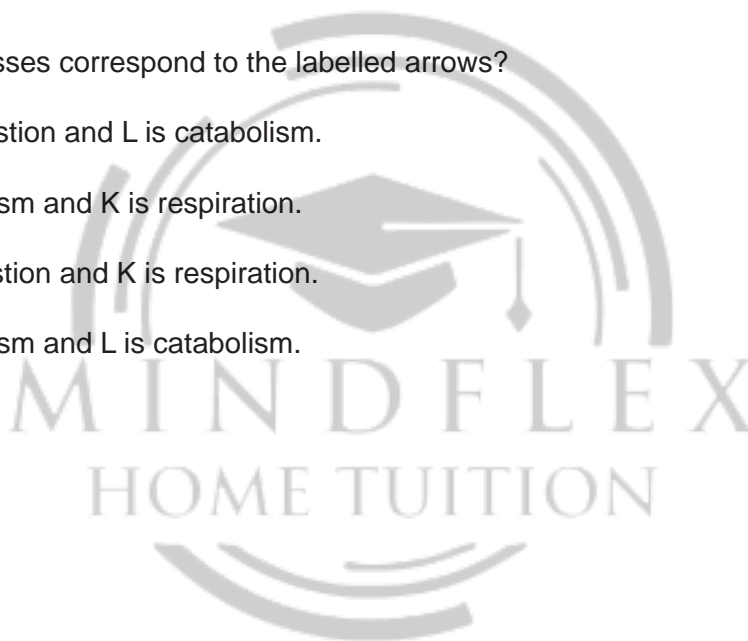
15. The diagram shows the carbon cycle.



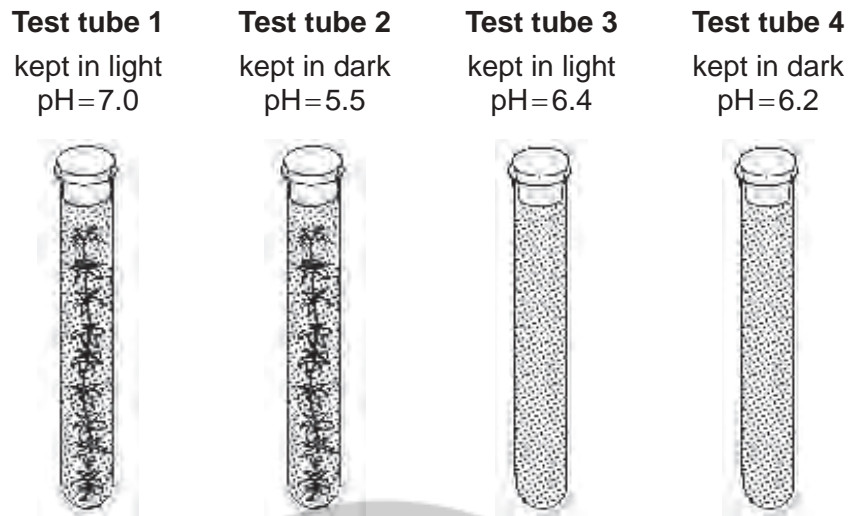
[Source: © International Baccalaureate Organization 2017]

Which two processes correspond to the labelled arrows?

- A. K is combustion and L is catabolism.
- B. J is anabolism and K is respiration.
- C. J is combustion and K is respiration.
- D. J is anabolism and L is catabolism.



16. An experiment was set up so that each test tube contained water at a pH of 6.3 and a pH indicator. Test tubes 1 and 2 also contained a common pond autotroph. Carbon dioxide dissolves in water and forms carbonic acid. After three days the four test tubes were found to have these results.



What conclusion can be drawn from test tube 1 and test tube 2?

	Test tube 1	Test tube 2
A.	photosynthesis has used CO ₂	respiration has produced CO ₂
B.	photosynthesis has made the water more acidic	respiration has made the water less acidic
C.	photosynthesis occurred but not respiration	respiration occurred but not photosynthesis
D.	no conclusion can be drawn, since pH in the controls has changed	

17. The table shows the number of differences between humans and other selected organisms for the protein cytochrome c oxidase. This protein, consisting of 104 amino acids, is located in the mitochondria and functions as an enzyme during cell respiration.

Organism pairs	Number of amino acid differences
Human – chimpanzee	0
Human – fruit fly	29
Human – horse	12
Human – pigeon	12
Human – rattlesnake	14
Human – rhesus monkey	1
Human – screwworm fly	27
Human – snapping turtle	15
Human – tuna fish	21

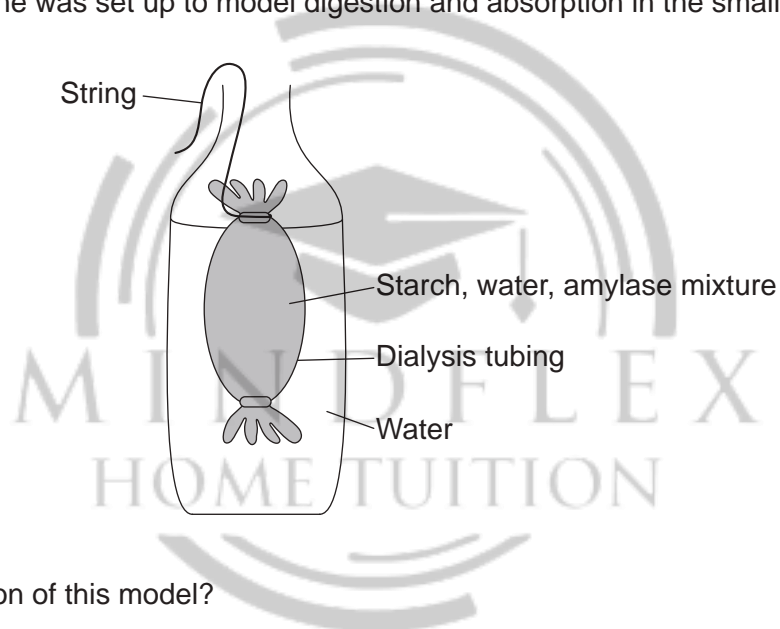
If the data were used to draw a cladogram, which chordates would be furthest apart from humans?

- A. Chimpanzee because it has zero differences
- B. Fruit fly because it has the most differences
- C. Tuna fish because it is the chordate with the most differences
- D. Horse because it is in the same class
18. What causes variation within a population?
- A. Fertilization and change in the environment
- B. Fertilization and mutation
- C. Mutation and evolution
- D. Evolution and adaptive radiation

19. Which of the organisms A–D, identified by the key, represents a reptile?

- 1. fins, gills, 2-chamber heart fish
no fins, more than 2 chambers in heart go to 2
- 2. mucus on skin, gills and lungs A.
no gills, breathes with lungs go to 3
- 3. dry scales, lays eggs on land or live birth B.
constant body temperature, 4 limbs go to 4
- 4. lays eggs with hard shells C.
hair or fur, live birth D.

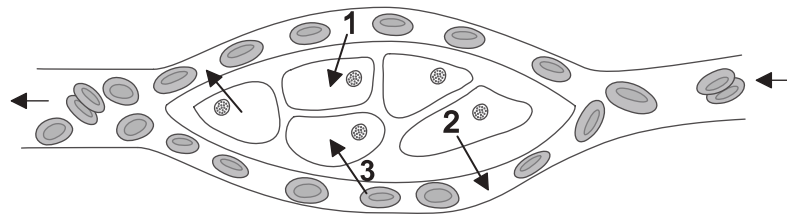
20. Dialysis membrane was set up to model digestion and absorption in the small intestine.



What is a limitation of this model?

- A. There can be no active transport.
- B. Maltose will pass through the membrane.
- C. Lipase should be present with protein.
- D. The membrane is not permeable to starch.

21. The diagram shows red blood cells and undifferentiated tissue cells.



[Source: © International Baccalaureate Organization 2017]

Diffusion of oxygen from blood cells to tissue cells is represented by arrow 3 in the diagram. What molecules are shown diffusing by arrow 1 and arrow 2?

	Arrow 1	Arrow 2
A.	carbon dioxide	urea
B.	water	glucose
C.	glucose	carbon dioxide
D.	fatty acids	amino acids

22. What can protect the body from blood loss?

- A. Antibodies
- B. Fibrin
- C. Histamines
- D. Hemophilia

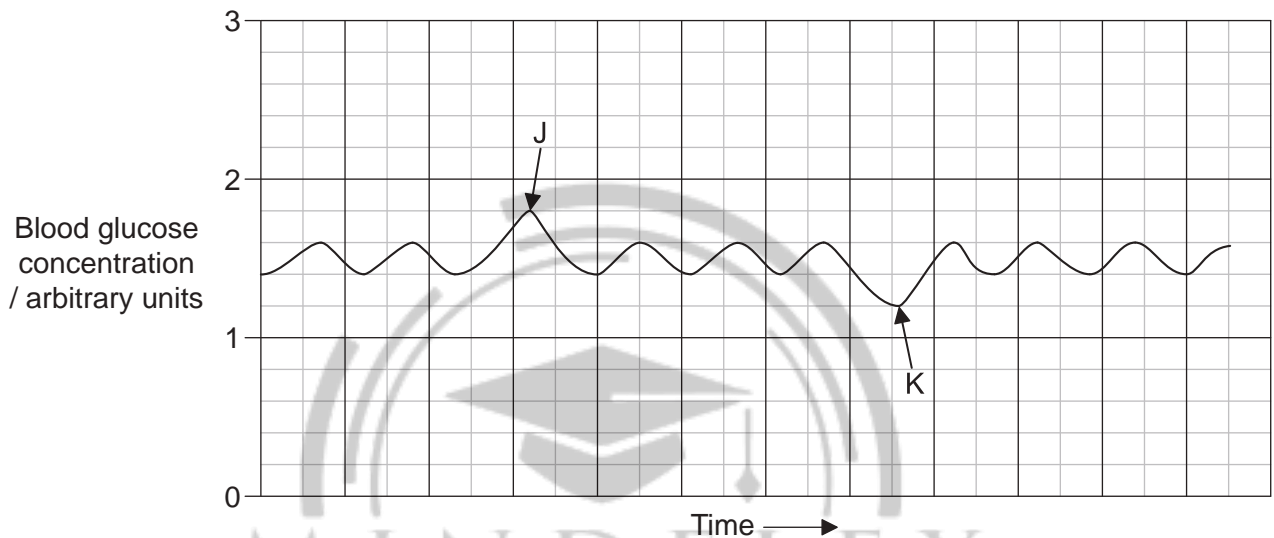
23. Which type of cell is specialized to facilitate gas exchange?

- A. Type I pneumocytes
- B. Type II pneumocytes
- C. Internal intercostal muscle fibres
- D. External intercostal muscle fibres

24. What happens when an action potential reaches motor end plates?

- A. Calcium ions are absorbed by the muscle fibres.
- B. The sarcomeres relax.
- C. Neurotransmitter is released.
- D. Action potential is passed to the neuron.

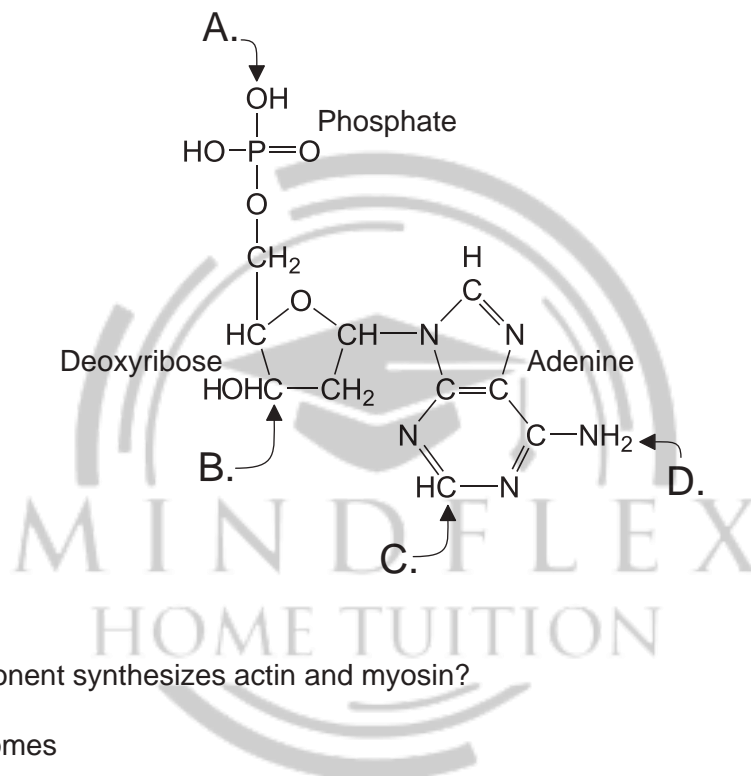
25. The graph shows changes in an individual's blood glucose concentration over time.



What hormones were secreted at J and K?

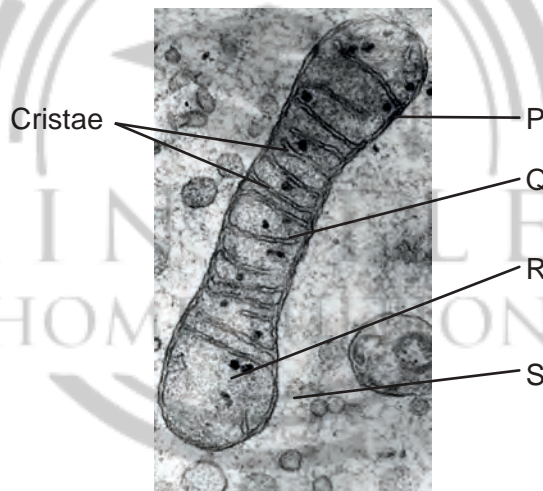
	J	K
A.	epinephrine	insulin
B.	insulin	glucagon
C.	glucagon	insulin
D.	thyroxin	epinephrine

26. Some regions of DNA do not code for the production of proteins. What are these regions of DNA used as?
- A. They have no known function and are recycled to provide nucleotides
 - B. Gene regulation and coding for production of enzymes used in translation
 - C. Telomeres and coding for production of tRNA
 - D. Introns and coding for production of structural proteins
27. Which letter (A–D) indicates where a new nucleotide would attach?



28. Which cell component synthesizes actin and myosin?
- A. Free ribosomes
 - B. Rough endoplasmic reticulum
 - C. Smooth endoplasmic reticulum
 - D. Nuclear membrane

29. Which reaction does **not** cause a net release of energy?
- A. ADP combines with inorganic phosphate to form ATP
 - B. ATP releases inorganic phosphate to form ADP
 - C. Loss of hydrogen from reduced NAD
 - D. Oxidation of reduced FAD
30. Which process occurs during the light-dependent reaction of photosynthesis?
- A. ATP, CO₂ and H₂O are produced.
 - B. CO₂ is used to produce carbohydrates.
 - C. ATP and O₂ are produced.
 - D. RuBP is phosphorylated.
31. The image shows a portion of a cell containing a mitochondrion.

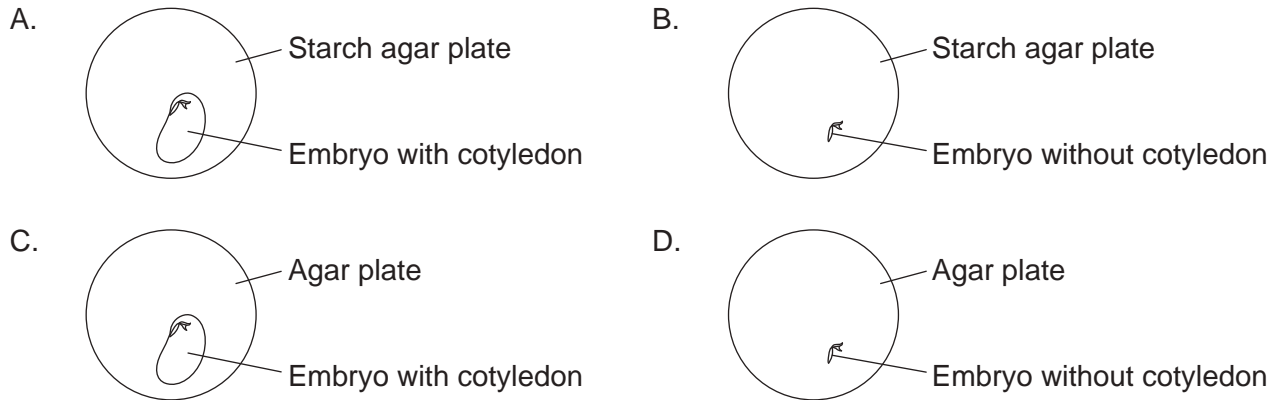


[Source: 'TEM of a mitochondrion' by Prof. R. Bellairs. Credit: Prof. R. Bellairs. CC BY 4.0.]

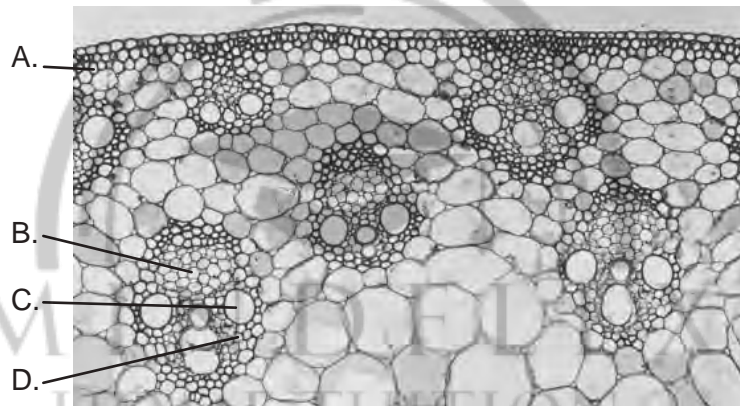
Where do glycolysis and electron transport occur?

	Glycolysis	Electron transport
A.	P	R
B.	R	Q
C.	R	R
D.	S	Q

32. Agar is a growth medium without nutrients; starch agar is agar with starch added to it. Seed coats were removed from seeds and the seeds were used to set up the following conditions. Which plant embryo was **unable** to grow?



33. Which letter identifies phloem?



[Source: E R DEGGINGER/Getty Images]

34. Cobalt chloride paper is blue when dry but turns pink with water. Blue cobalt chloride paper was fastened to the upper and lower surfaces of a plant leaf. After 20 minutes, many small pink dots were observed on the paper on the lower surface, and a few pink dots were seen on the upper surface. What conclusions can be drawn?

- I. There are more stomata on the lower surface than on the upper surface.
- II. Stomata on the upper surface are blocked by the waxy cuticle.
- III. More transpiration occurs through the lower surface than through the upper surface.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

35. How do the concepts of gradualism and punctuated equilibrium differ?
- A. The timing of evolution
 - B. The mechanism causing evolution
 - C. The sequence of evolutionary events
 - D. The reality of evolution

36. In a plant, dark leaves are dominant to pale leaves and yellow seeds are dominant to white seeds.

A heterozygous dark-leaved plant with yellow seeds was crossed with a pale-leaved plant with white seeds. A large number of offspring were produced. They were either dark-leaved with yellow seeds or pale-leaved with white seeds in equal number.

What is the **most** likely cause of this pattern?

- A. Crossing over has occurred.
 - B. The two genes are linked.
 - C. The traits are polygenic.
 - D. The genes are codominant.
37. What forms the basis of immunity after vaccination?

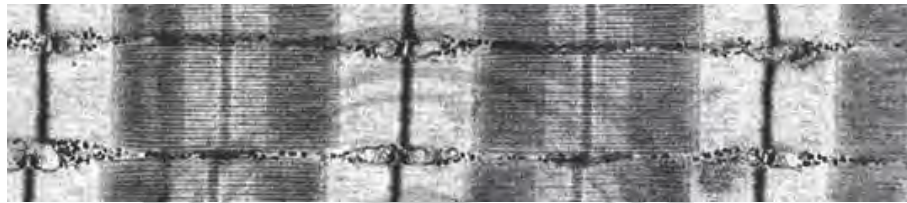
	Production of histamines	Clonal selection	Production of memory cells
A.	yes	no	no
B.	yes	no	yes
C.	no	yes	no
D.	no	yes	yes

38. Which processes require calcium?

- I. Muscle contraction
- II. Movement of an action potential along an axon
- III. Production of the skeleton of hard corals

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

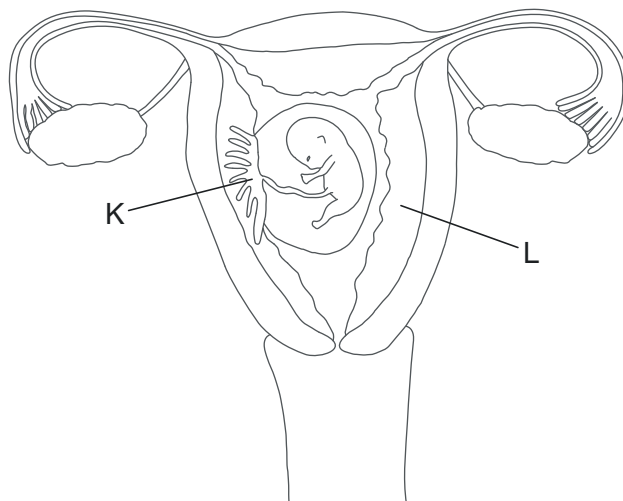
39. What structure is indicated by the arrows?



[Source: Courtesy Roger Craig, University of Massachusetts]

- A. One muscle fibre
- B. One sarcomere
- C. One myofibril
- D. One Z line

40. The diagram shows the female reproductive system.



[Source: © International Baccalaureate Organization 2017]

Which structures do K and L identify?

	K	L
A.	endometrium	uterine wall
B.	placenta	endometrium
C.	amnion	placenta
D.	fetus	uterine wall

Markscheme

November 2017

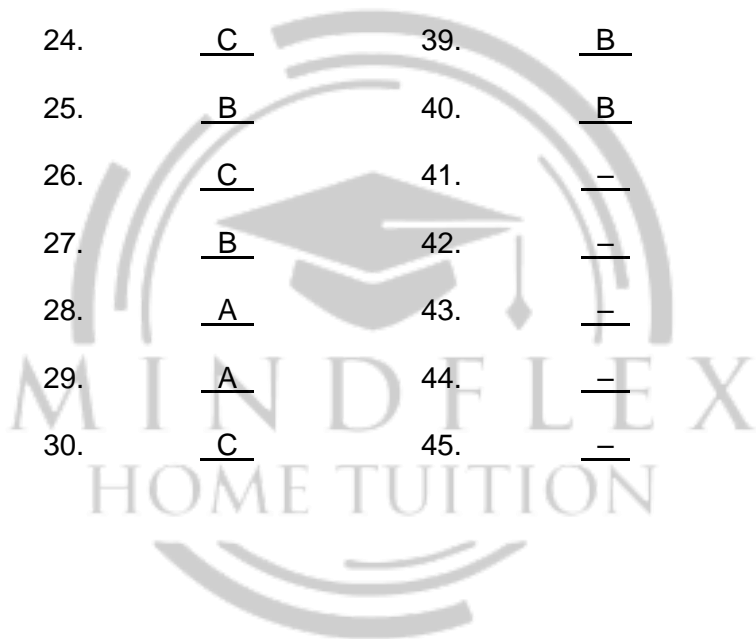

Biology

Higher level

Paper 1

2 pages

1.	<u>A</u>	16.	<u>A</u>	31.	<u>D</u>	46.	<u>-</u>
2.	<u>B</u>	17.	<u>C</u>	32.	<u>D</u>	47.	<u>-</u>
3.	<u>B</u>	18.	<u>B</u>	33.	<u>B</u>	48.	<u>-</u>
4.	<u>A</u>	19.	<u>B</u>	34.	<u>B</u>	49.	<u>-</u>
5.	<u>B</u>	20.	<u>A</u>	35.	<u>A</u>	50.	<u>-</u>
6.	<u>C</u>	21.	<u>C</u>	36.	<u>B</u>	51.	<u>-</u>
7.	<u>D</u>	22.	<u>B</u>	37.	<u>D</u>	52.	<u>-</u>
8.	<u>D</u>	23.	<u>A</u>	38.	<u>B</u>	53.	<u>-</u>
9.	<u>C</u>	24.	<u>C</u>	39.	<u>B</u>	54.	<u>-</u>
10.	<u>D</u>	25.	<u>B</u>	40.	<u>B</u>	55.	<u>-</u>
11.	<u>C</u>	26.	<u>C</u>	41.	<u>-</u>	56.	<u>-</u>
12.	<u>B</u>	27.	<u>B</u>	42.	<u>-</u>	57.	<u>-</u>
13.	<u>B</u>	28.	<u>A</u>	43.	<u>-</u>	58.	<u>-</u>
14.	<u>C</u>	29.	<u>A</u>	44.	<u>-</u>	59.	<u>-</u>
15.	<u>C</u>	30.	<u>C</u>	45.	<u>-</u>	60.	<u>-</u>



Biology
Higher level
Paper 2

Wednesday 15 November 2017 (afternoon)

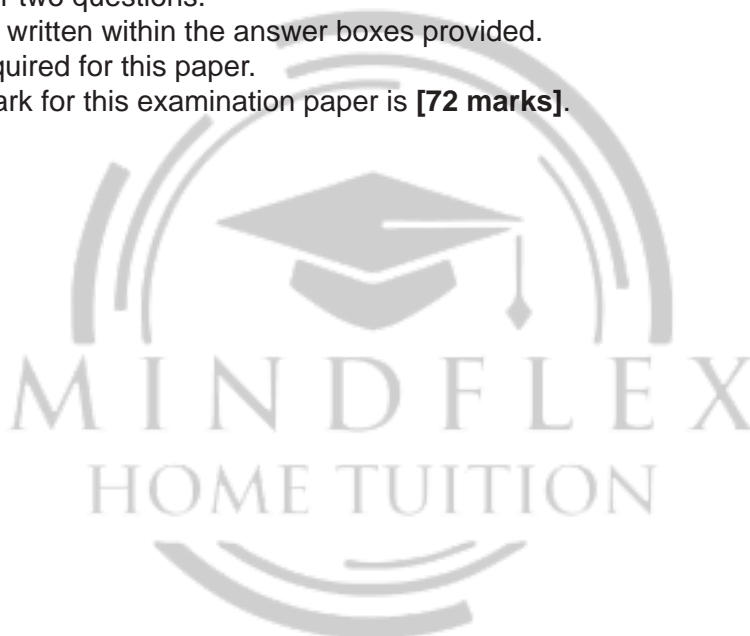
Candidate session number

2 hours 15 minutes

--	--	--	--	--	--	--	--	--	--

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]

.....

.....

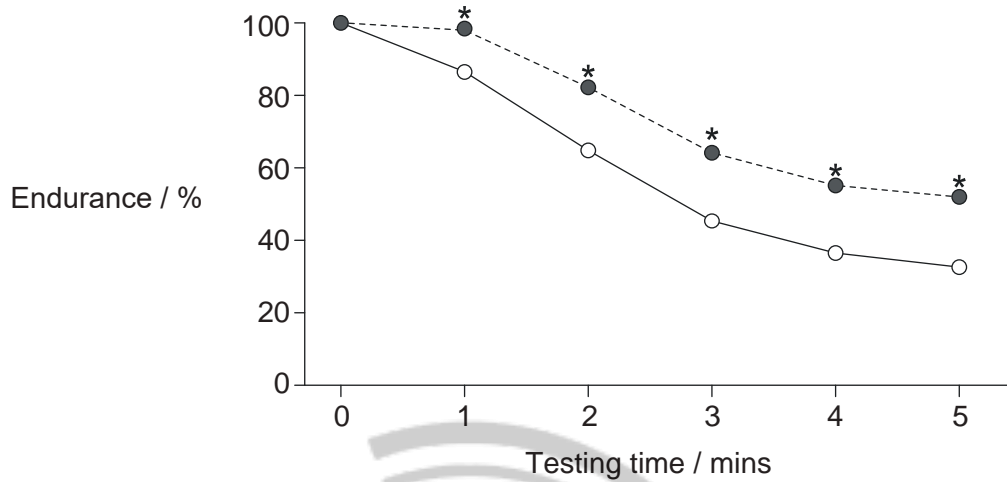
.....

(This question continues on the following page)



(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]

.....

.....

.....

.....

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

.....

.....

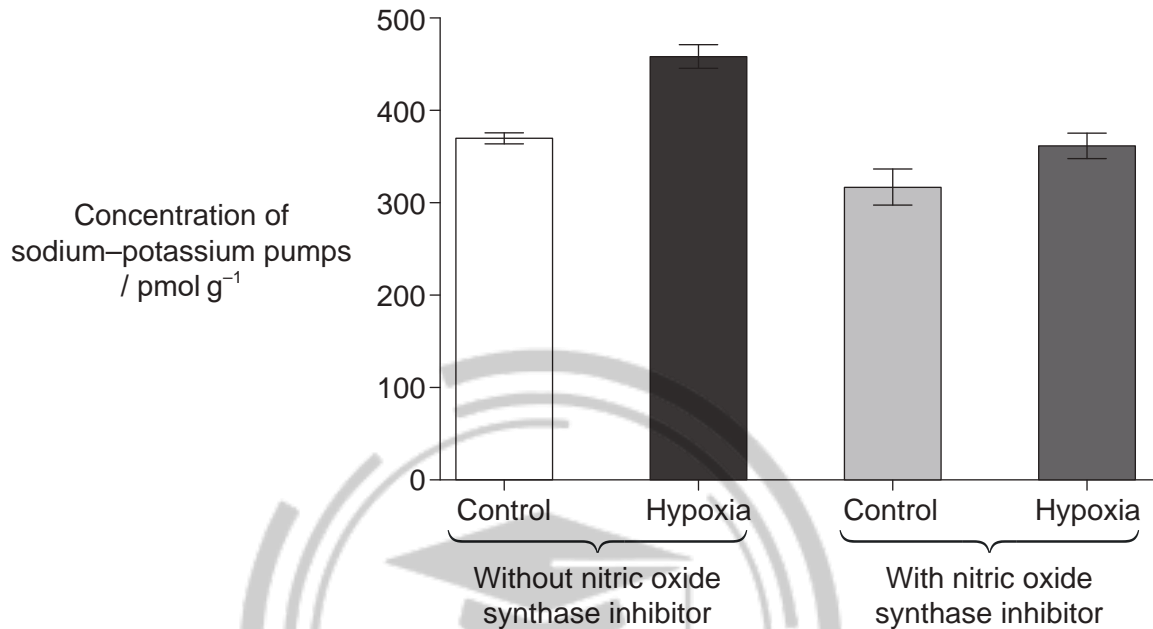
.....

.....

(This question continues on the following page)

(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]

.....

.....

.....

- (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]

.....

.....

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

.....

.....

(This question continues on the following page)

(Question 1 continued)

- (f) Using all relevant data in the question, evaluate the effectiveness of the rats' adaptation to hypoxia. [3]

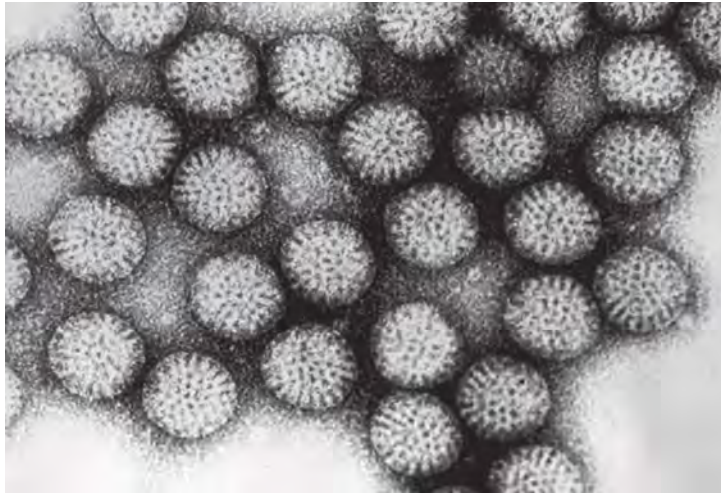
.....
.....
.....
.....
.....
.....

- (g) Discuss the advantages and disadvantages of using rats as models in this investigation. [2]

.....
.....
.....
.....



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]

.....
.....
.....

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

[2]

.....
.....
.....
.....

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

[1]

.....
.....

(This question continues on the following page)

(Question 2 continued)

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

[2]

.....
.....
.....
.....

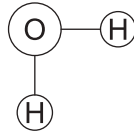
(ii) State **one** possible use of hybridoma cells.

[1]

.....
.....
.....



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]

MIND FLEX
HOME TUITION

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

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]

.....

(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]

.....

.....

.....

.....

.....

.....



5. (a) Describe the process of crossing over. [2]

.....

.....

.....

.....

.....

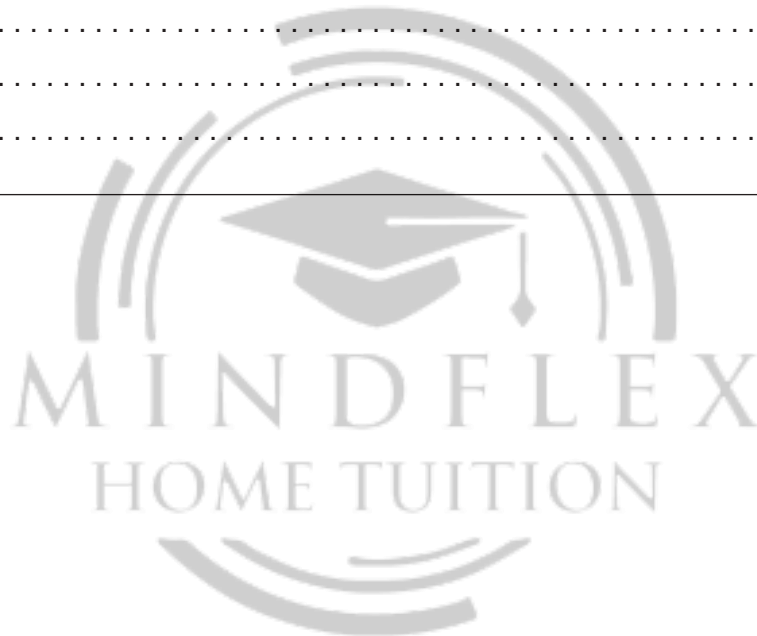
- (b) Explain the reason for linked genes **not** following the pattern of inheritance discovered by Mendel. [2]

.....

.....

.....

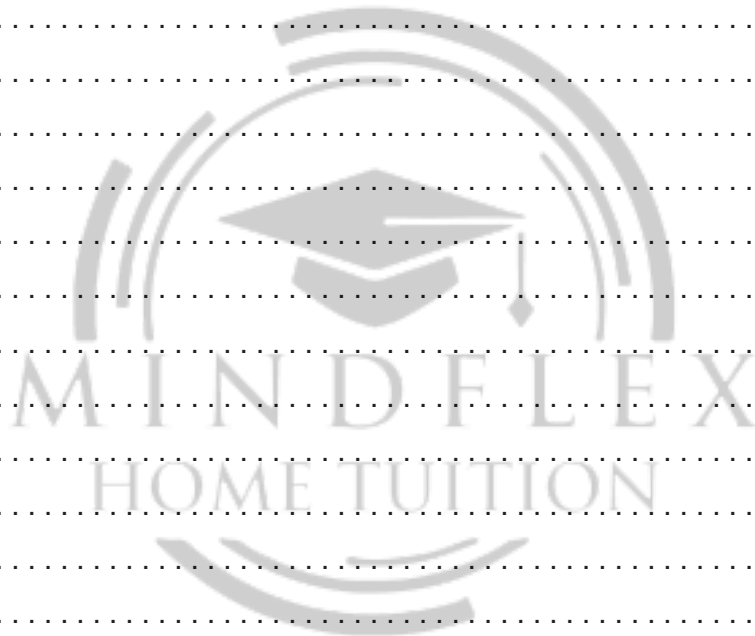
.....



Section B

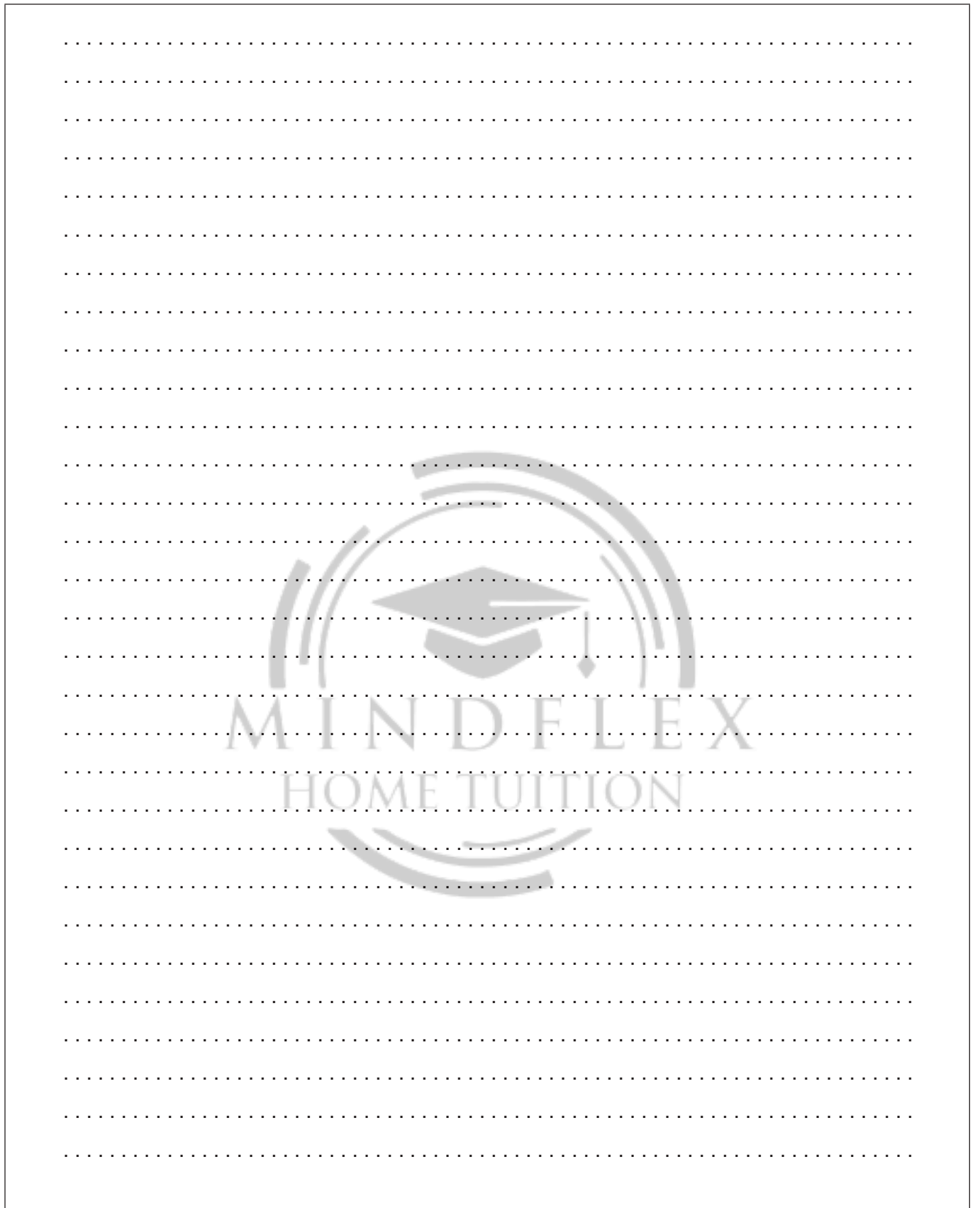
Answer **two** questions. Up to one additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

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]



A large rectangular area containing horizontal dotted lines for writing. A watermark logo is centered on the page, featuring a graduation cap and the text "MINDFLEX HOME TUITION".





Biology
Higher level
Paper 3

Thursday 16 November 2017 (morning)

Candidate session number

1 hour 15 minutes

--	--	--	--	--	--	--	--	--	--

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[45 marks]**.

Section A	Questions
Answer all questions.	1 – 3

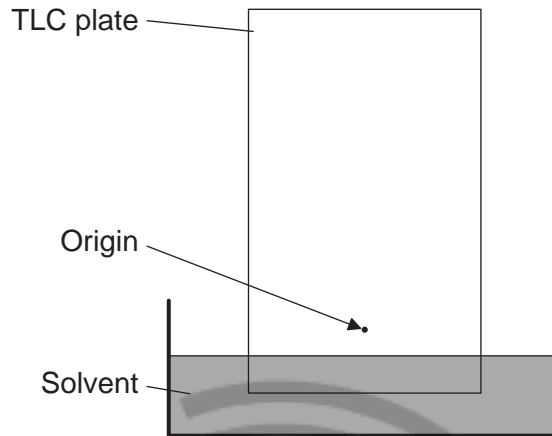
Section B	Questions
Answer all of the questions from one of the options.	
Option A — Neurobiology and behaviour	4 – 8
Option B — Biotechnology and bioinformatics	9 – 13
Option C — Ecology and conservation	14 – 18
Option D — Human physiology	19 – 23



Section A

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

1. R_f values for photosynthetic pigments may be determined using the technique of thin-layer chromatography (TLC).



- (a) Outline what happens when spinach extract is spotted on a TLC plate and placed into a container of solvent. [2]

.....

.....

.....

.....

MIND FLEX
HOME TUITION

- (b) Explain what the R_f values represent in chromatography. [3]

.....

.....

.....

.....

.....

.....

(This question continues on the following page)



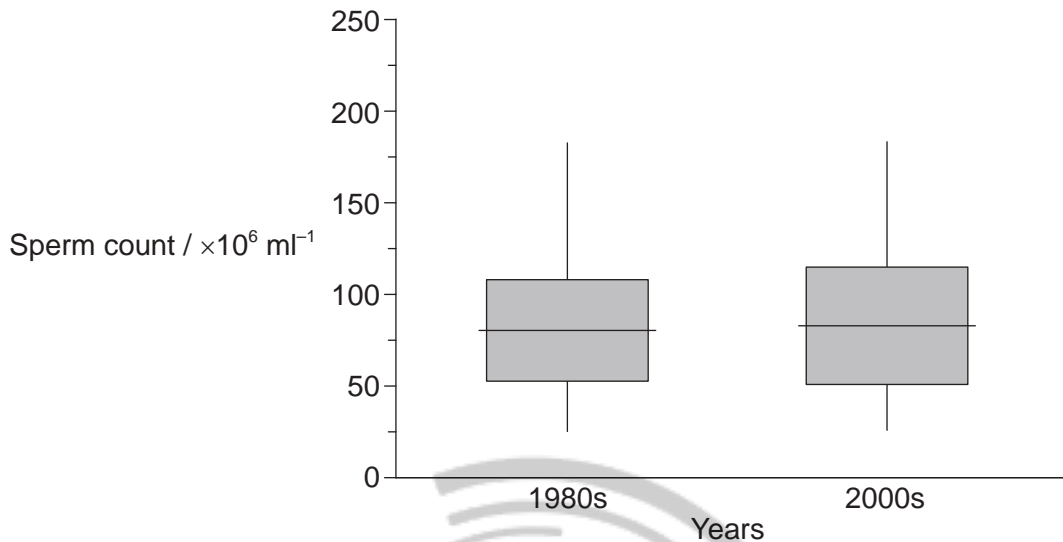
(Question 1 continued)

(c) State **two** photosynthetic pigments that could be identified using chromatography. [1]

1.
2.



2. Concerns have been raised about the effect of rising pollution levels on sperm production in men. To investigate the possible effects of pollution on spermatogenesis, sperm samples from men of similar ages were collected in Kolkata in the 1980s and 2000s. The box plot represents the mean and range of sperm counts in the 1980s and 2000s.



[Source: Republished with permission of Elsevier Science and Technology Journals, from 'Semen quality and age-specific changes: A study between two decades on 3729 male partners of couples with normal sperm count and attending an andrology laboratory for infertility-related problems in an Indian city', Dyutiman Mukhopadhyay, Alex C. Varghese, Manisha Pal, Sudip K. Banerjee, Asok K. Bhattacharyya, Rakesh K. Sharma, and Ashok Agarwal, *Fertility and Sterility*, 93 (7), 2009; permission conveyed through Copyright Clearance Center, Inc]

- (a) A hypothesis has been suggested that pollution may have a negative effect on spermatogenesis. Evaluate whether the data support this hypothesis.

[3]

.....

.....

.....

.....

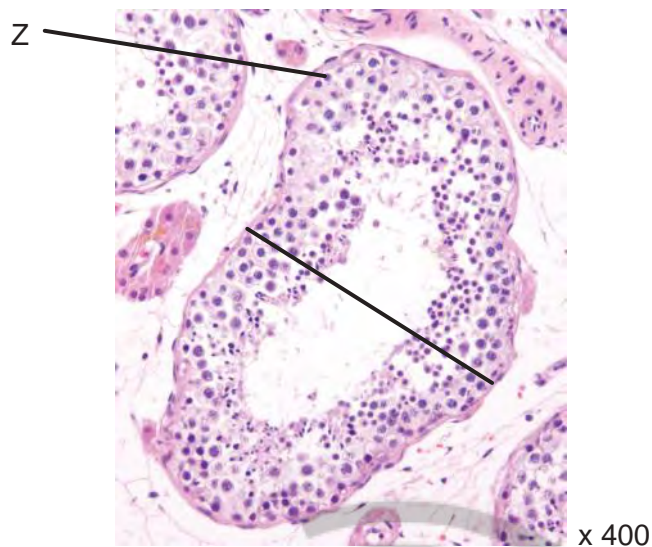
.....

.....

(This question continues on the following page)

(Question 2 continued)

- (b) The light micrograph shows a cross section of seminiferous tubules.



[Source: Micrograph of a seminiferous tubule with sperm by Nephron
(https://commons.wikimedia.org/wiki/File:Seminiferous_tubule_and_sperm_low_mag.jpg)]

- (i) Calculate the actual size of the seminiferous tubule in the area indicated by the line across it, giving the units. [1]

MIND FLEX
HOME TUITION

.....

- (ii) Identify the type of cell labelled Z. [1]

.....

Please **do not** write on this page.

Answers written on this page
will not be marked.



3. (a) The Hershey and Chase experiment supported DNA as the hereditary material. Describe the experiment.

[3]

.....

.....

.....

.....

.....

.....

- (b) Some regions of DNA act as telomeres or produce tRNA. State **one** other function of DNA sequences that do **not** code for protein.

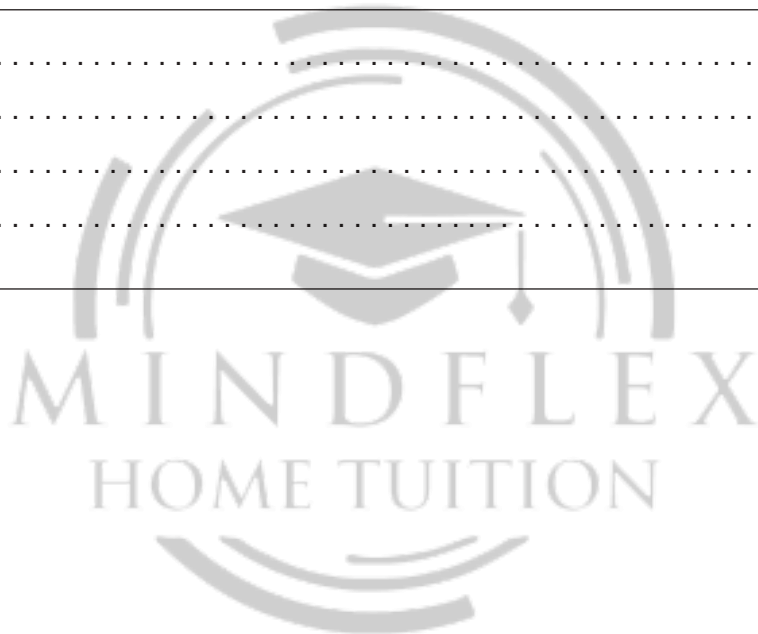
[1]

.....

.....

.....

.....

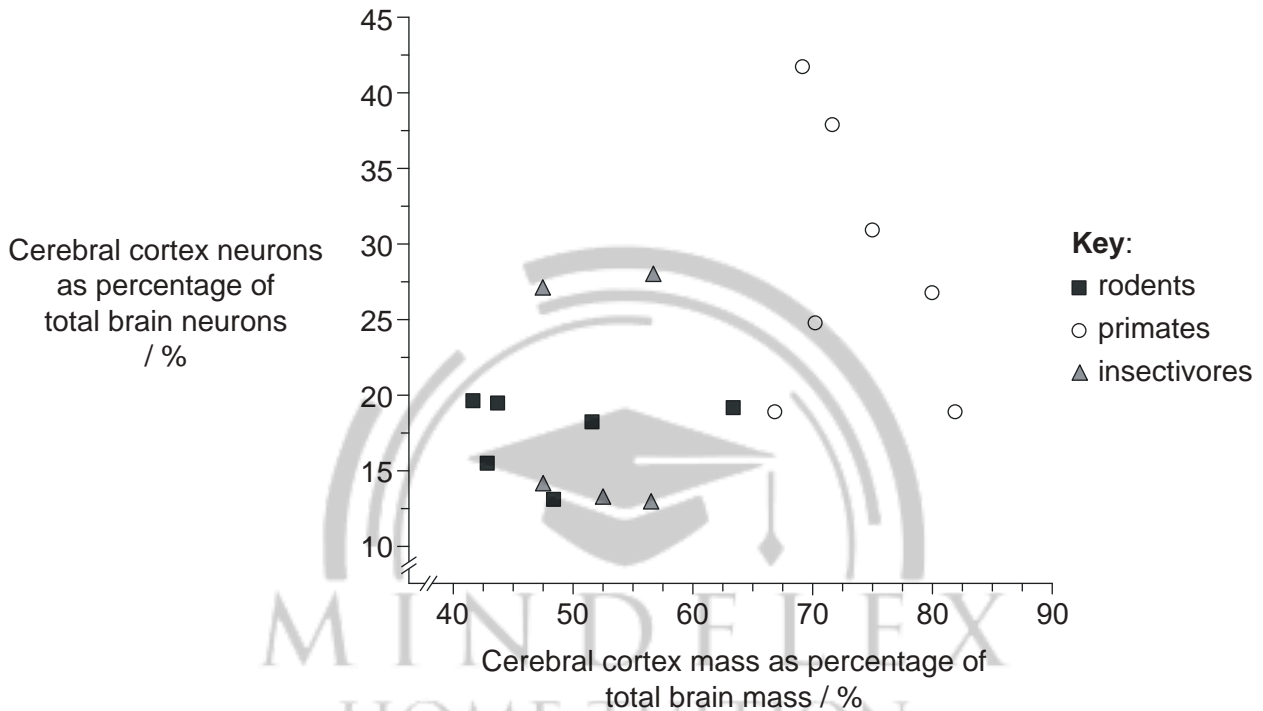


Section B

Answer **all** of the questions from **one** of the options. Answers must be written within the answer boxes provided.

Option A — Neurobiology and behaviour

4. The graph shows the correlation between the cerebral cortex mass and the number of neurons in the cerebral cortex of three groups of mammals (rodents, primates and insectivores). Each point indicates the mean number from different research studies for the species.



[Source: S Herculano-Houzel (2009) *Frontiers in Human Neuroscience*, 3, p 31, Frontiers Research Foundation <http://journal.frontiersin.org/article/10.3389/neuro.09.031.2009/full>]

- (a) (i) State which group has the lowest percentage of cerebral cortex mass. [1]

.....

- (ii) Suggest advantages of the cerebral cortex containing a high percentage of the brain's neurons. [2]

.....
.....
.....
.....

(Option A continues on the following page)

(Option A, question 4 continued)

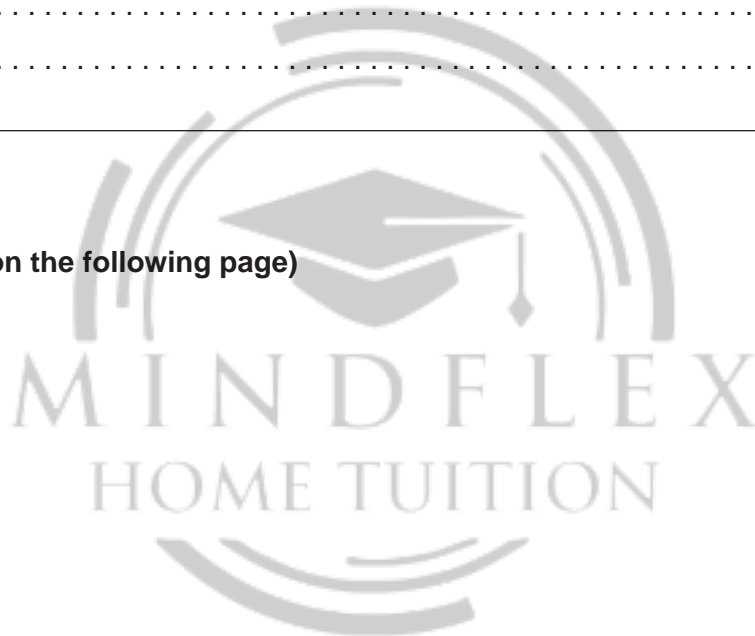
- (b) Suggest a role for the cerebral cortex in rodents such as rats and mice. [1]

.....

- (c) Explain how the cerebral cortex in humans differs from other mammals. [3]

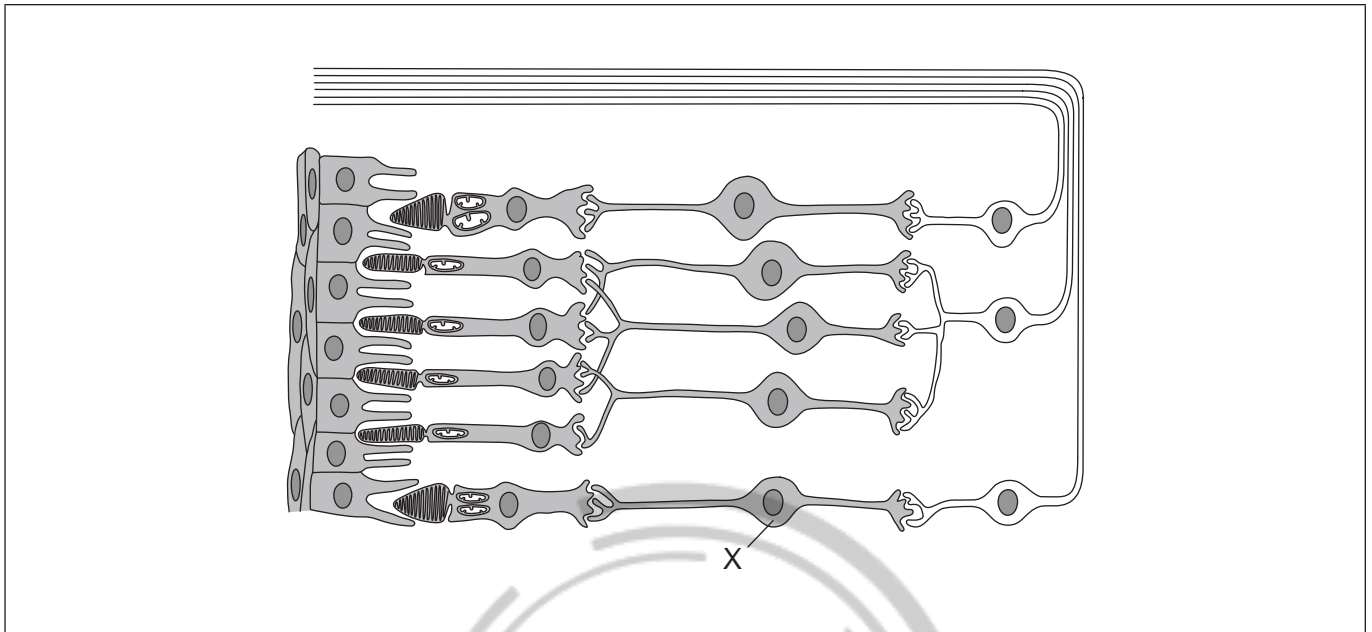
.....
.....
.....
.....
.....
.....

(Option A continues on the following page)



(Option A continued)

5. (a) The diagram shows part of a retina.



[Source: C. J. Clegg, *Introduction to Advanced Biology*, 2000, p. 285. Reproduced by permission of Hodder Education.]

- (i) Identify the cell labelled X. [1]

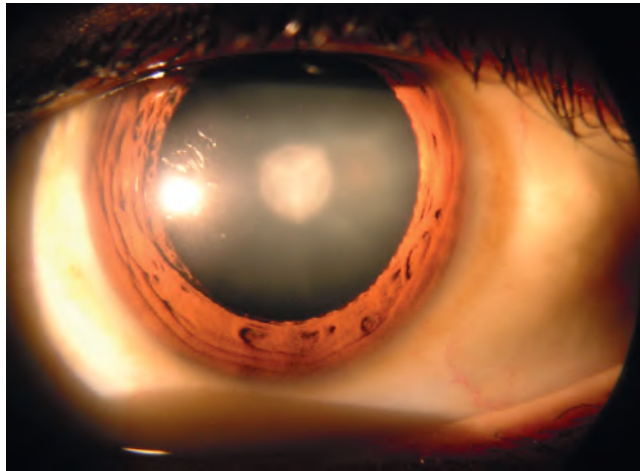


- (ii) Draw an arrow to show the direction of light through the retina. [1]

(Option A continues on the following page)

(Option A, question 5 continued)

- (b) A cataract is a clouding of the lens in the eye, resulting in blurred vision.



[Source: Cataract in Human Eye, Rakesh Ahuja, MD
(https://en.wikipedia.org/wiki/Cataract#/media/File:Cataract_in_human_eye.png)]

Explain the use of a local anesthetic during surgery to remove the cataract.

[2]

.....

.....

.....

.....

MINDFLEX
HOME TUITION

- (c) Describe red-green colour blindness.

[2]

.....

.....

.....

.....

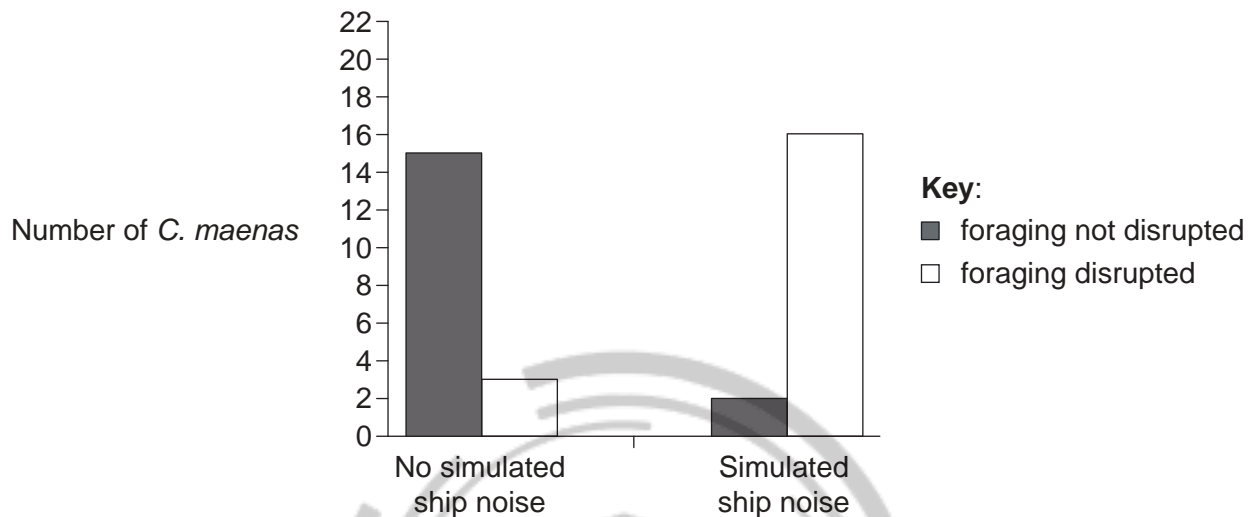
.....

.....

(Option A continues on the following page)

(Option A continued)

6. Noise from ships has the capacity to disrupt the foraging behaviour of shore crabs (*Carcinus maenas*). In this study, *C. maenas* were collected from Newquay Harbour in the UK and held for a maximum of 48 hours in salt-water tanks located at a neighbouring aquarium. The graph shows the effect of simulated ship noise on the time spent foraging for food by *C. maenas*.



[Source: Republished with permission of Elsevier Science and Technology Journals, from 'Noise negatively affects foraging and antipredator behaviour in shore crabs', Matthew A. Wale, Stephen D. Simpson, Andrew N. Radford, *Animal Behaviour* 86, 2013; permission conveyed through Copyright Clearance Center, Inc]

- (a) State the effect of simulated ship noise on foraging behaviour. [1]

.....

- (b) Predict the consequences on *C. maenas* of increasing noise related to human activity. [3]

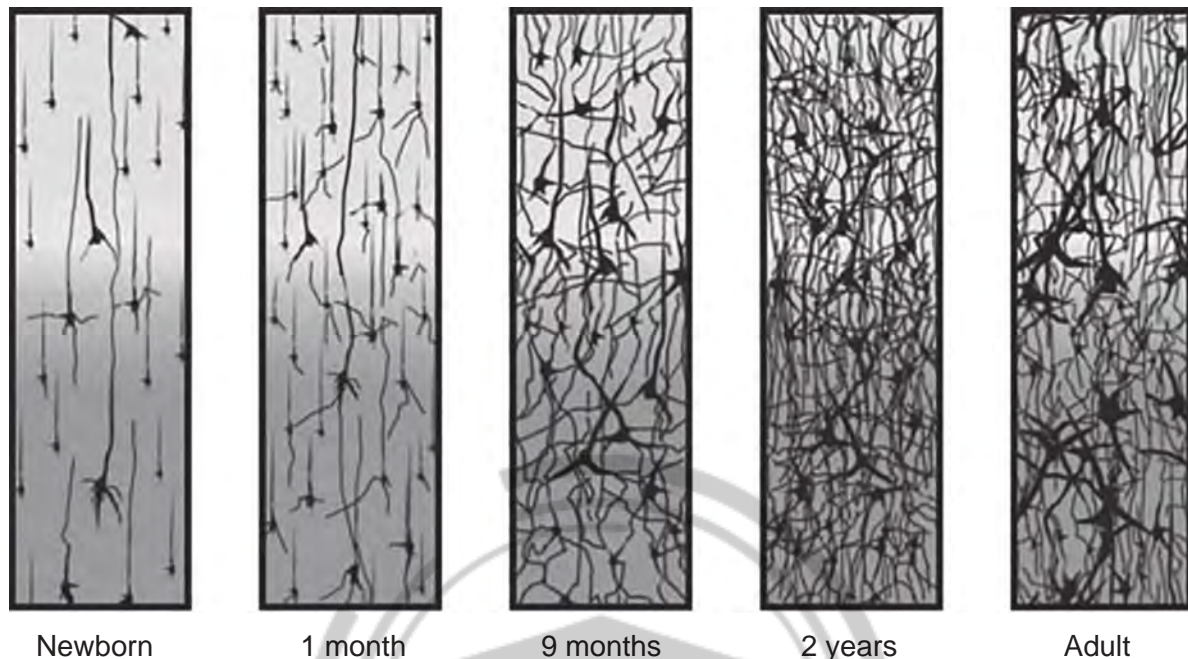
.....
.....
.....
.....
.....
.....

(Option A continues on the following page)



(Option A continued)

7. The diagrams illustrate changes in synapse density of the cerebral cortex from newborn to adult.



[Source: THE POSTNATAL DEVELOPMENT OF THE HUMAN CEREBRAL CORTEX, VOLUMES IVIII,
by Jesse LeRoy Conel, Cambridge, Mass.: Harvard University Press,
Copyright © 1939, 1941, 1947, 1951, 1955, 1959, 1963, 1967
by the President and Fellows of Harvard College.
Copyright © renewed 1967, 1969, 1975, 1979, 1983, 1987, 1991]

- (a) Explain the processes illustrated by the diagrams.

[4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Option A continues on the following page)

(Option A, question 7 continued)

- (b) Outline how the human brain can reorganize itself following a stroke. [1]

.....
.....
.....

- (c) State the area of the human brain that may have been damaged when the following symptoms are present.

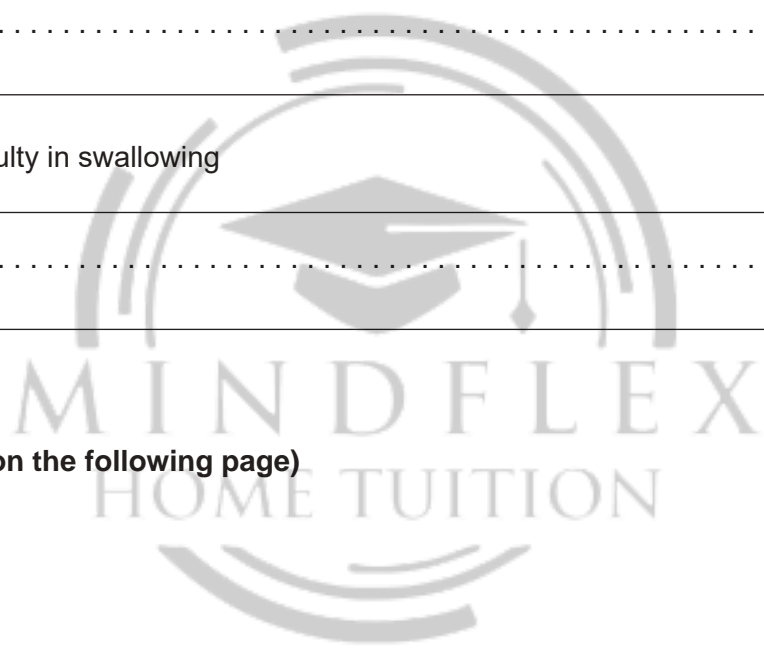
- (i) A lack of muscle control on the left side of the body [1]

.....

- (ii) Difficulty in swallowing [1]

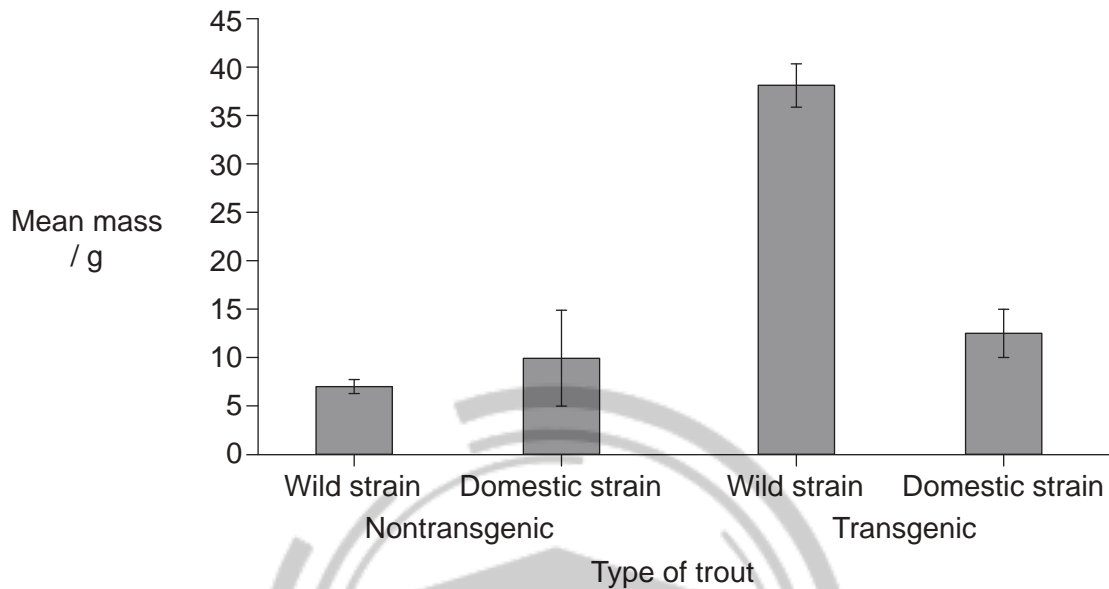
.....

(Option A continues on the following page)



Option B — Biotechnology and bioinformatics

9. Transgenic rainbow trout (*Oncorhynchus mykiss*) were produced from both wild strain and domestic strain trout, using a gene coding for growth hormone from coho salmon (*Oncorhynchus kisutch*). The graph shows the mean mass of the nontransgenic and transgenic trout at 8 months post-fertilization.



[Source: Reprinted by permission from Macmillan Publishers Ltd: *Nature*, 409, Growth of domesticated transgenic fish, R H Devlin *et al.*, pp. 781–782, copyright 2001]

- (a) Analyse the data for the growth of nontransgenic trout and transgenic trout.

[2]

.....

.....

.....

.....

- (b) Suggest a reason for the growth differences between the nontransgenic trout and transgenic trout.

[1]

.....

.....

.....

(Option B continues on the following page)



(Option B, question 9 continued)

- (c) Describe the use of marker genes in the development of transgenic organisms such as trout. [2]

.....
.....
.....
.....

- (d) Outline the possible environmental impact associated with the accidental release of transgenic trout. [2]

.....
.....
.....
.....

(Option B continues on the following page)



(Option B continued)

10. The table shows a comparison of DNA base sequences in several yeast (*Saccharomyces*) genomes.

Species	Number of DNA base sequences	Percentage of coding sequences
<i>S. paradoxus</i>	728	88
<i>S. cariacanus</i>	867	88
<i>S. mikatae</i>	1136	84
<i>S. bayanus</i>	851	80
<i>S. castellii</i>	2290	70
<i>S. kluyveri</i>	2145	70
<i>S. unisporus</i>	2357	69

[Source: P. F. Cliften *et al.* (2001) 'Surveying *Saccharomyces* Genomes to Identify Functional Elements by Comparative DNA Sequence Analysis', *Genome Research*, 11, pp. 1175–1186.
© Cold Spring Harbor Laboratory Press. Reproduced with permission.]

- (a) Identify the species that has the lowest percentage of coding sequences. [1]

.....

- (b) State how similar nucleotide sequences can be identified. [1]

.....
.....

(Option B continues on the following page)



(Option B, question 10 continued)

- (c) The yeast *Saccharomyces cerevisiae* was the first eukaryotic organism to have its entire genome sequenced. Suggest reasons for the choice of yeast as a study organism. [3]

.....

.....

.....

.....

.....

.....

- (d) Outline possible medical applications of the polymerase chain reaction (PCR). [1]

.....

.....

.....

(Option B continues on the following page)



(Option B continued)

11. The scanning electron micrograph shows a biofilm on a metal surface from an industrial water system.



[Source: Biofilms: Survival Mechanisms of Clinically Relevant Microorganisms,
Rodney M. Donlan, J. William Costerton, *Clinical Microbiology Reviews*, 2002, 15 (2), pp. 167–193.
Reproduced with permission from American Society for Microbiology]

- (a) Outline the emergent properties of biofilms.

[3]

MIND FLEX
HOME TUITION

.....
.....
.....
.....
.....
.....

- (b) State a positive application of biofilms.

[1]

.....
.....

(Option B continues on the following page)



(Option B, question 11 continued)

- (c) Suggest **two** problems that could be caused by the presence of biofilms in water systems.

[2]

1.
2.

12. (a) Beans contribute to flatulence. Alpha-galactosidase, derived from the fungus *Aspergillus niger*, is an enzyme that breaks down the fibre usually fermented by bacteria, reducing intestinal gas. Describe how alpha-galactosidase would be produced using *A. niger* in a continuous fermenter.

[3]

.....
--

- (b) Temperature is a variable that needs to be continually monitored in deep-tank batch fermentation of penicillin. List **two** other variables that need to be monitored.

[2]

1.
2.

(Option B continues on page 23)

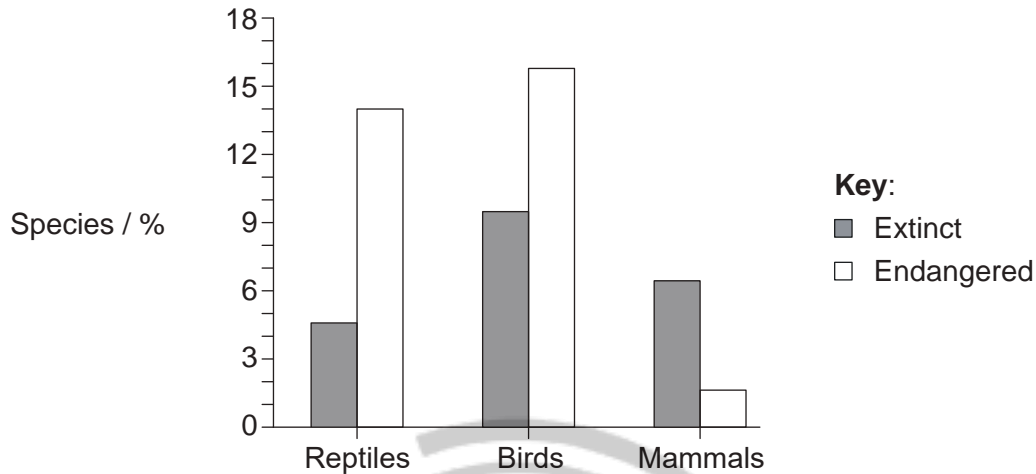
Please **do not** write on this page.

Answers written on this page
will not be marked.



Option C — Ecology and conservation

14. To assess the impact of introduced cats (*Felis silvestris*) that prey on native species, a study was carried out on 120 islands around the world. The graph shows the impact of *F. silvestris* on reptiles, birds and mammals.



[Source: A global review of the impacts of invasive cats on island endangered vertebrates, F. M. Medina *et al.* (2011) *Global Change Biology*, 17, pp. 3503–3510. Reproduced with permission from John Wiley and Sons.]

- (a) (i) Identify how the pattern in mammals is different from reptiles and birds. [1]

.....

.....

- (ii) Describe how invasive species such as *F. silvestris* can have a significant impact on native species. [2]

.....

.....

.....

.....

- (iii) Suggest a method to limit the impact of *F. silvestris* on native species. [1]

.....

.....

(Option C continues on the following page)

(Option C, question 14 continued)

- (b) The 'Ua'u petrel (*Pterodroma sandwichensis*) is considered to be an indicator species in the Hawaiian Islands.



[Source: https://commons.wikimedia.org/wiki/File:Oestrelata_phaeopygia_AvesHawaiienses00Wils_0382.jpg]

- (i) State the role of an indicator species. [1]

.....

- (ii) Identify possible approaches to maintain the population of *P. sandwichensis*. [2]

.....

.....

.....

.....

(Option C continues on the following page)

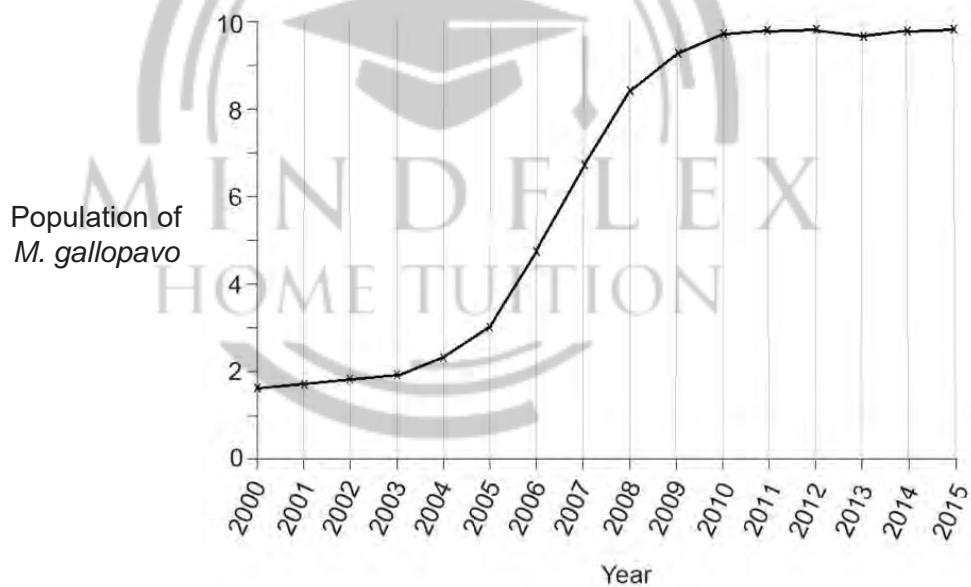
(Option C continued)

15. Wild turkeys (*Meleagris gallopavo*) once inhabited most forested areas of North America. As an important food source for early European settlers, the population of *M. gallopavo* seriously decreased. Due to recent conservation efforts, population numbers are increasing.



[Source: https://commons.wikimedia.org/wiki/File:A_wild_turkey_in_Middleboro,_Massachusetts.jpg]

The curve shows a population of *M. gallopavo* from 2000 to 2015 in Ohio in the mid-western USA.



[Source: © International Baccalaureate Organization 2017]

(Option C continues on the following page)



(Option C, question 15 continued)

- (a) (i) State the range of years when exponential growth of the *M. gallopavo* population occurred. [1]

.....

- (ii) Suggest factors that could account for the growth curve of the *M. gallopavo* population. [2]

.....
.....
.....
.....

- (b) State how the population of *M. gallopavo* may have been determined. [1]

.....
.....

- (c) Hunting of *M. gallopavo* is currently regulated. Predict what would happen if the hunting regulations were removed. [2]

.....
.....
.....
.....

(Option C continues on the following page)

(Option C continued)

16. The graph shows the variation in the annual temperature and precipitation in different ecosystems.

Removed for copyright reasons

- (a) Identify the ecosystem labelled X. [1]

.....

- (b) Compare and contrast the exchange of energy with nutrient cycling in ecosystems. [3]

.....
.....
.....
.....
.....

(Option C continues on the following page)



(Option C, question 16 continued)

- (c) Outline **three** issues arising from the release of pollutants into the environment. [3]

1.

2.

3.

17. (a) (i) Define fundamental niche. [1]

.....
.....

- (ii) Outline a reason for organisms seldom occupying their entire fundamental niche. [1]

.....
.....

- (b) Describe the relationship between *Zooxanthellae* and reef-building coral species. [2]

.....
.....
.....
.....

(Option C continues on page 31)

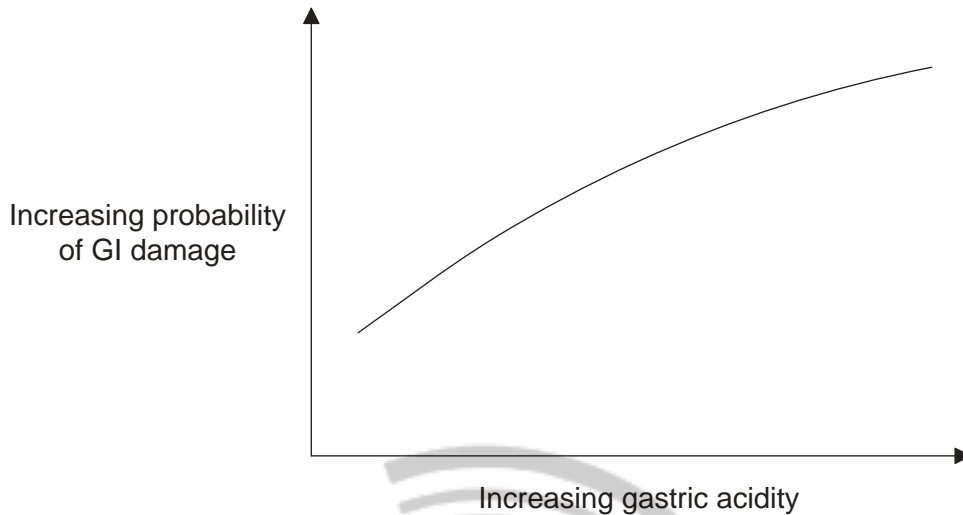


Please **do not** write on this page.

Answers written on this page
will not be marked.

Option D — Human physiology

19. The graph shows the relationship between gastrointestinal (GI) damage and gastric acidity in 37 healthy human volunteers.



[Source: Republished with permission of Elsevier Science and Technology Journals, from 'Integrated gastric acidity can predict the prevention of naproxen-induced gastroduodenal pathology in normal subjects', John Plachetka, Gaetano Morelli, Carolyn Hines, Julie Borland, Alison Lyke, Diane Littlefield, Jerry D. Gardner *Gastroenterology*, Vol. 124, Issue 4, 2003; permission conveyed through Copyright Clearance Center, Inc.]

- (a) State the relationship of gastric acidity and GI damage. [1]

.....
.....
.....

- (b) GI damage can include ulcers. Outline the treatment of stomach ulcers. [3]

.....
.....
.....
.....
.....
.....

(Option D continues on the following page)



(Option D, question 19 continued)

- (c) Other than gastric acidity, state a primary cause of stomach ulcers. [1]

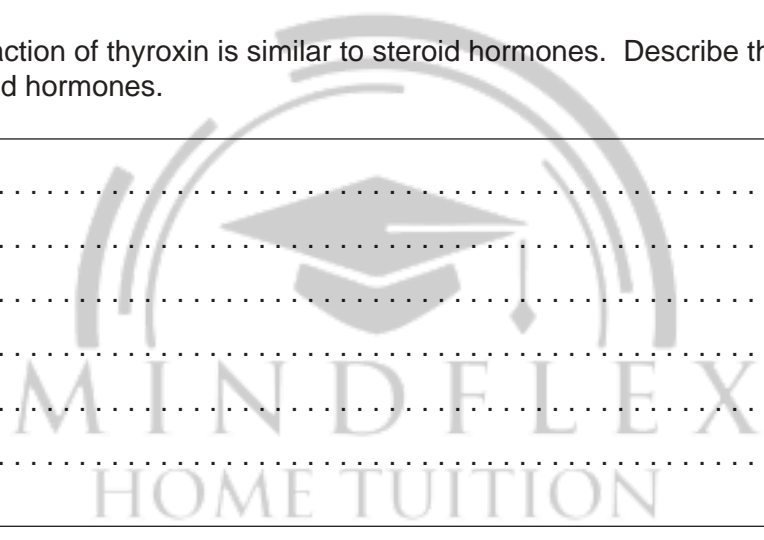
.....

20. (a) (i) Thyroxin is a hormone produced in the thyroid gland. State **one** function of thyroxin. [1]

.....
.....

- (ii) The action of thyroxin is similar to steroid hormones. Describe the action of steroid hormones. [3]

.....
.....
.....
.....
.....
.....
.....
.....



- (b) The World Health Organization recommends that the iodine intake should be supplemented in pregnant women due to their increased requirements. Outline the need for iodine supplementation. [2]

.....
.....
.....
.....

(Option D continues on the following page)



(Option D continued)

21. (a) (i) Jaundice causes a yellow discolouration of the skin, mucous membranes and sclera of the eyes. State the bile pigment causing this discolouration. [1]

.....

- (ii) Explain how the normal production of bile pigments changes with the development of jaundice. [4]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

- (b) Distinguish between the structure of liver sinusoids and capillaries. [2]

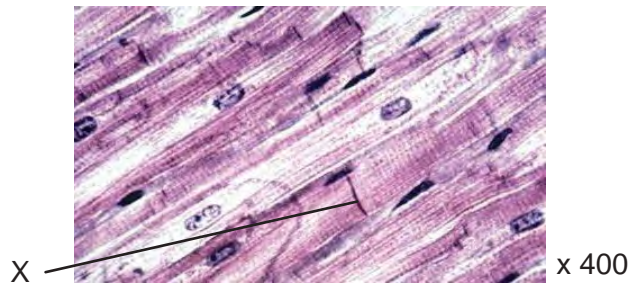
.....
.....
.....
.....

(Option D continues on the following page)



(Option D continued)

22. The micrograph shows a section of cardiac muscle.



[Source: Musculocardiaco by Goyitrina (<https://commons.wikimedia.org/wiki/File:Musculocardiaco.jpg>)]

(a) Identify the structure labelled X. [1]

.....

(b) Describe the unique properties of cardiac muscle cells. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) State an early invention that led to improved knowledge of the heart. [1]

.....

(Option D continues on the following page)

