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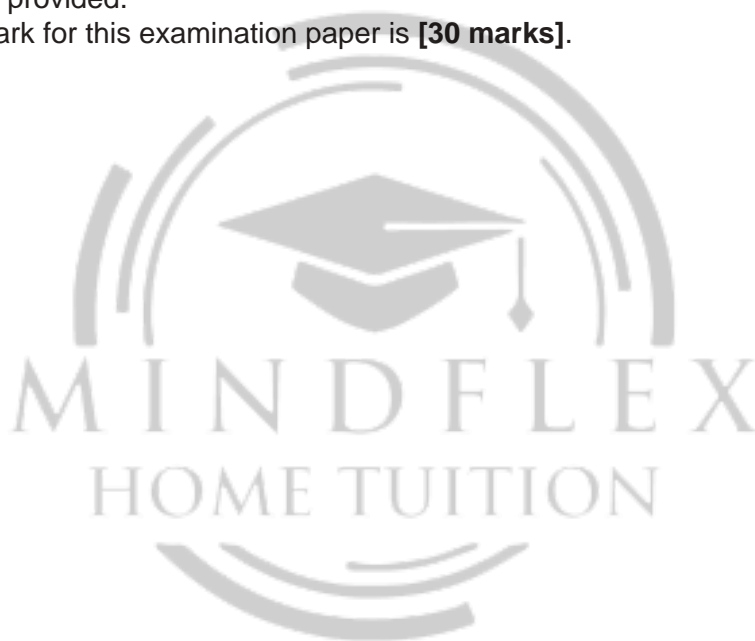
Biology
Standard level
Paper 1

Thursday 5 November 2015 (morning)

45 minutes

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 **[30 marks]**.



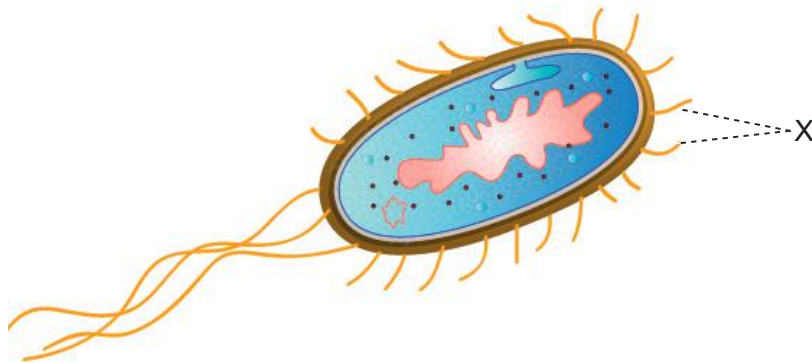
1. Two populations of the same fish species were fed different diets to investigate the effect of differing nutrition on their growth. What is an appropriate method to determine the significance of a resulting difference?
 - A. Calculate the mean for each population
 - B. Calculate the standard deviation for each population
 - C. Graph the results
 - D. Perform a *t*-test

2. Which shows the order of size from smallest to largest?
 - A. Viruses → cell membrane thickness → eukaryotic cells → prokaryotic cells
 - B. Cell membrane thickness → prokaryotic cells → viruses → eukaryotic cells
 - C. Cell membrane thickness → viruses → prokaryotic cells → eukaryotic cells
 - D. Viruses → cell membrane thickness → prokaryotic cells → eukaryotic cells

3. Animal cells often secrete glycoproteins as extracellular components. What is a role of these glycoproteins?
 - A. Adhesion
 - B. Additional energy reserve
 - C. Membrane fluidity
 - D. Water uptake

4. During which stage does the cell surface area to volume ratio decrease?
 - A. Interphase
 - B. Metaphase
 - C. Telophase
 - D. Cytokinesis

5. The image represents an *Escherichia coli*.

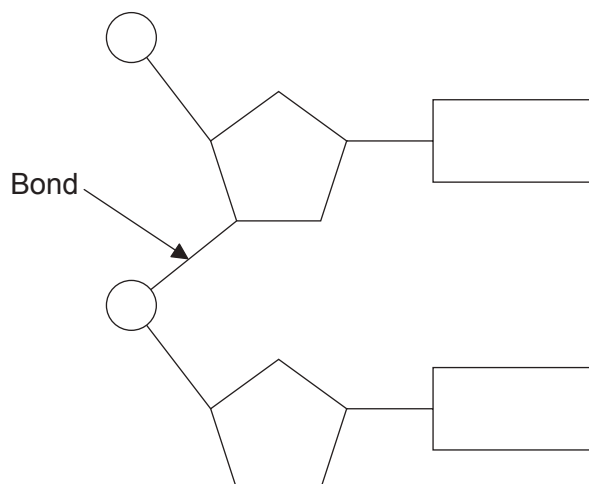


[Source: https://upload.wikimedia.org/wikipedia/commons/8/84/Escherichia_coli_by_togopic.png]

What is the function of structure X?

- A. Active transport
B. Attachment
C. Binary fission
D. Cell respiration
6. Which always contains carbon, hydrogen and oxygen?
- I. Carbohydrate
II. Protein
III. Fat
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III
7. Which molecule can be hydrolyzed?
- A. Glycerol
B. Maltose
C. Fructose
D. Galactose

8. The diagram shows a dinucleotide.



Which type of bond is identified by the arrow?

- A. Phosphate
 - B. Hydrogen
 - C. Covalent
 - D. Peptide
9. What is required to replicate DNA?
- A. Temperature of 37°C
 - B. Free nucleotides carrying A, C, G and T bases
 - C. Plasmids
 - D. Endonuclease

10. How is the information in the genetic code used?
- A. To predict the genotype of gametes
 - B. To distinguish prokaryotic genomes from eukaryotic genomes
 - C. To deduce phenotypes in pedigree charts
 - D. To translate mRNA into polypeptides
11. What describes anaerobic cell respiration?
- A. Glucose break down to pyruvate
 - B. Carbon dioxide fixation
 - C. No ATP formation
 - D. Occurs in the mitochondrion
12. In a person who is heterozygous for sickle-cell anemia, where is the mutation found?
- A. In every gamete produced
 - B. Only in gametes carrying an X chromosome
 - C. In all brain cells
 - D. In blood plasma
13. During which stage of meiosis does crossing over usually occur?
- A. Prophase I
 - B. Metaphase I
 - C. Prophase II
 - D. Metaphase II

14. What is the chromosome number in a human gamete with non-disjunction?
- A. 46
 - B. 45
 - C. 24
 - D. 23
15. In a human with type A blood, what determines the blood group?
- A. Sex chromosomes
 - B. One or two alleles
 - C. Multiple alleles
 - D. Codominant alleles
16. A colour blind man and a woman carrier for colour blindness have a son. What is the probability that their son will be colour blind?
- A. 25%
 - B. 50%
 - C. 75%
 - D. 100%
17. Laboratory analysis of DNA from a 40 000 year old woolly mammoth used the polymerase chain reaction (PCR). What role did the PCR have in the analysis?
- A. DNA denaturation
 - B. DNA comparison
 - C. DNA separation
 - D. DNA amplification

18. The image shows a female Golden Orb-weaving spider (*Nephila plumipes*). They can grow as large as 4 cm and build webs strong enough to trap small birds for food.



[Source: © Mark Crocker. Used with permission.]

Which of the following describe(s) this spider?

- I. Primary consumer
 - II. Heterotroph
 - III. Arthropod
- A. I only
 - B. I and II only
 - C. II and III only
 - D. I, II and III



19. Image I shows a spotted hyena (*Crocuta crocuta*) and image II shows a leopard tortoise (*Geochelone pardalis*).

Image I



[Source: DesertUSA.Com]

Image II

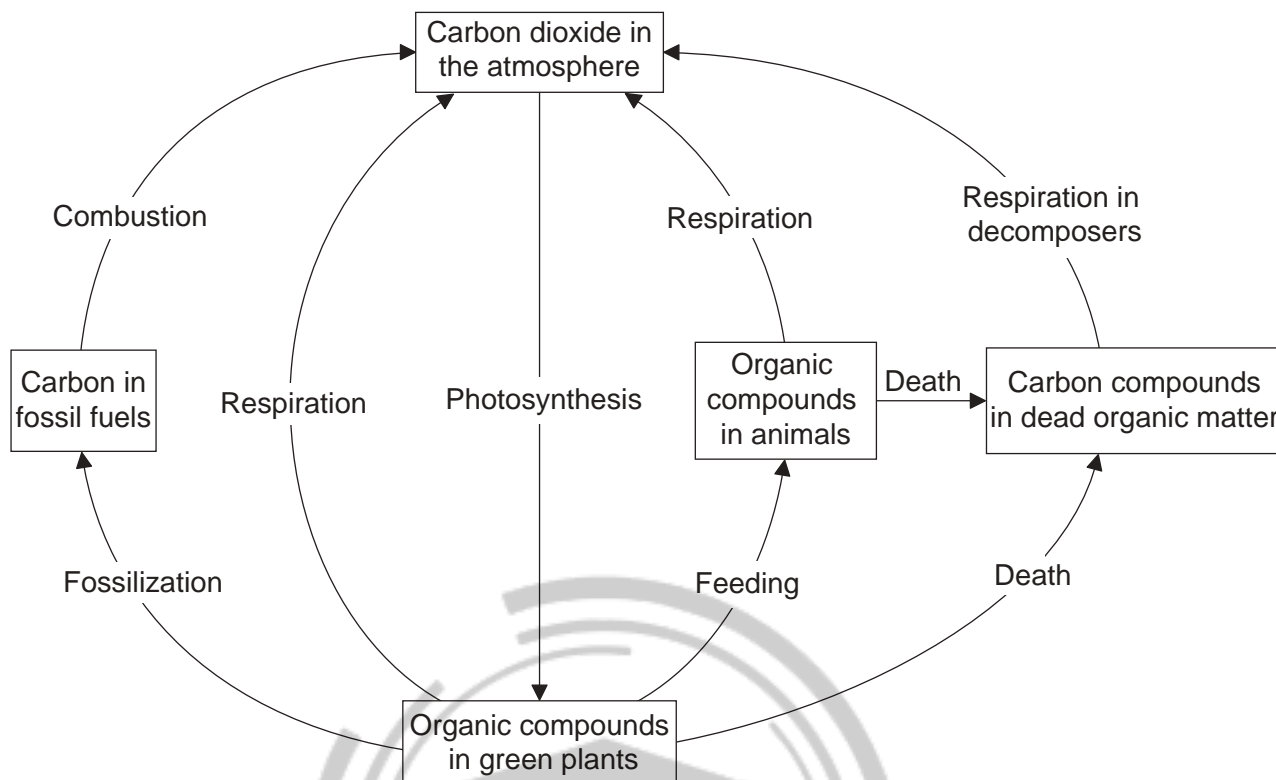


[Source: "Geochelone pardalis bw 01" by Berthold Werner - Own work. Licensed under CC BY-SA 3.0 via Commons - https://commons.wikimedia.org/wiki/File:Geochelone_pardalis_bw_01.jpg#/media/File:Geochelone_pardalis_bw_01.jpg]

Based on their diet, the feces of spotted hyenas appear white because of high calcium content. Leopard tortoises eat hyena feces. What would explain such tortoise behaviour?

- A. They are saprotrophs.
- B. They transform energy with 100% efficiency.
- C. They need to form bones and shell.
- D. They only eat inorganic matter.

20. The diagram represents the carbon cycle.



[Source: adapted from <http://content.answcdn.com>]

Which process has the greatest relative role in transferring carbon?

- A. Decomposition
 - B. Combustion
 - C. Photosynthesis
 - D. Cell respiration
21. What contributes to the enhanced greenhouse effect?
- A. Ozone from violent thunderstorms
 - B. Carbon particles in diesel engine exhaust
 - C. Methane from agricultural sources
 - D. Carbon dioxide from active volcanoes around the world

22. The image shows an *Acacia tortilis* tree which is one of 13 species of *Acacia*. All such flowering trees are examples of Fabaceae.



[Source: "Eat267". Licensed under CC BY-SA 3.0 via Commons - <https://commons.wikimedia.org/wiki/File:Eat267.jpg#/media/File:Eat267.jpg>]

What is the highest level of taxa for *Acacia tortilis*?

- A. *Acacia*
 - B. *Tortilis*
 - C. Fabaceae
 - D. Angiospermophyta
23. Darwin described evolution as "descent with modification". What would make evolution less probable?
- A. Stable environment
 - B. Migration
 - C. Variation in offspring
 - D. Random mutation
24. What structures in the small intestine transport most fats?
- A. Collecting ducts
 - B. Capillaries
 - C. Veins
 - D. Lacteals

25. What causes heart ventricles to fill with blood?
- I. Atrial contraction
 - II. Closing of atrioventricular valves
 - III. Opening of semilunar valves
- A. I only
 - B. I and II only
 - C. II and III only
 - D. III only
26. Which is the correct statement concerning HIV and AIDS?
- A. All HIV patients have AIDS.
 - B. HIV and AIDS are transmitted on the sex chromosomes.
 - C. All AIDS patients have HIV.
 - D. HIV and AIDS neutralize antibodies.
27. How does the hypothalamus respond to a very high body temperature?
- A. Increases muscle contraction
 - B. Stops receiving sensory input
 - C. Causes dilation of skin arterioles
 - D. Slows the heart rate
28. What is a characteristic of type II diabetes?
- A. Insufficient insulin
 - B. Insulin insensitivity
 - C. Excess glucagon
 - D. Low white blood cell count

29. Which two hormones promote thickening of the endometrium?

- A. FSH and LH
- B. Estrogen and FSH
- C. LH and estrogen
- D. Progesterone and estrogen

30. When the left ventricle is relaxed, what is the state of the valves?

	Atrioventricular valve	Semilunar valve
A.	closed	closed
B.	closed	open
C.	open	closed
D.	open	open



Biology
Standard level
Paper 2

Thursday 5 November 2015 (morning)

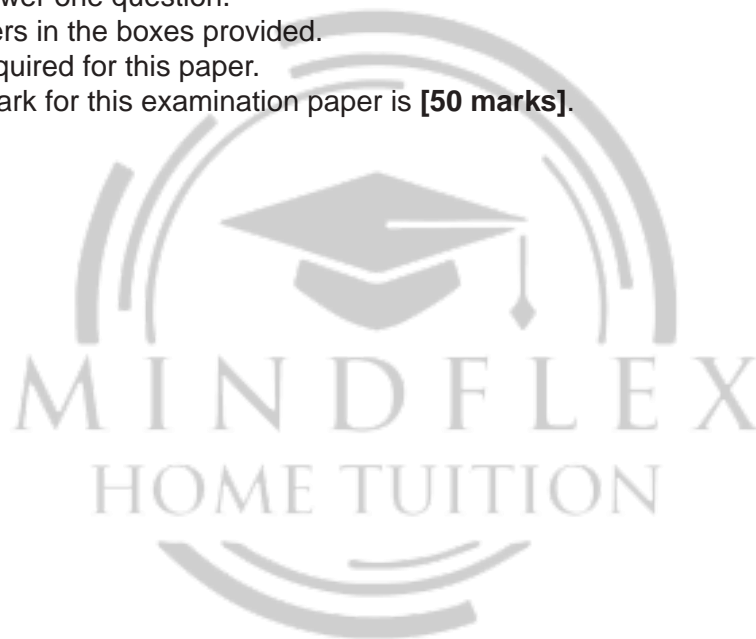
Candidate session number

1 hour 15 minutes

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Instructions to candidates

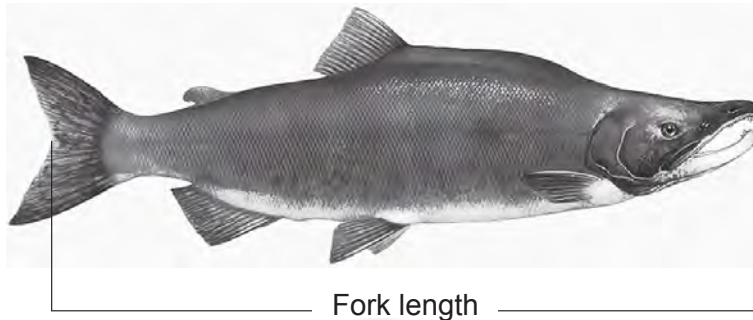
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer one question.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.



Section A

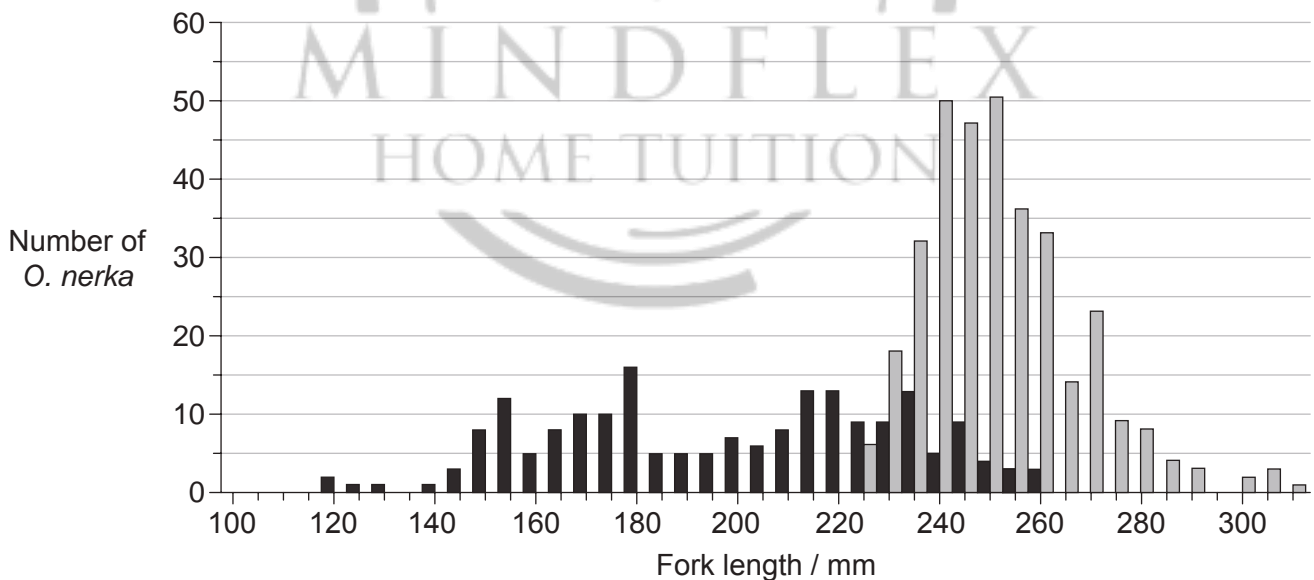
Answer **all** questions. Write your answers in the boxes provided.

1. Sockeye salmon (*Oncorhynchus nerka*) spend the first years of their lives in the freshwater lakes of Alaska before migrating to marine waters. Their first months in marine waters are spent foraging and growing near the shore line. They then move to offshore regions of the North Pacific Ocean for 2 to 3 years.



[Source: "Oncorhynchus nerka" by Timothy Knepp of the Fish and Wildlife Service. - US Fish and Wildlife Service. Licensed under Public Domain via Commons - https://commons.wikimedia.org/wiki/File:Oncorhynchus_nerka.jpg#/media/File:Oncorhynchus_nerka.jpg]

The graph shows fork length frequency of juvenile *O. nerka* caught during their first months in marine waters in autumn 2008 and ocean age one *O. nerka* caught 15 months later during winter 2009 in the North Pacific Ocean.



Key: ■ autumn 2008 (juvenile *O. nerka*) □ winter 2009 (ocean age one *O. nerka*)

[Source: Adapted from Edward V. Farley, Alexander Starovoytov, Svetlana Naydenko, Ron Heintz, Marc Trudel, Charles Guthrie, Lisa Eisner and Jeffrey R. Guyon (2011) 'Implications of a warming eastern Bering Sea for Bristol Bay sockeye salmon'. *ICES Journal of Marine Science*, 68 (6), pages 1138–1146, by permission of Oxford University Press.]

(This question continues on the following page)



(Question 1 continued)

- (a) Identify the most frequent fork length for *O. nerka* caught during autumn 2008 and winter 2009. [1]

Autumn 2008:
Winter 2009:

- (b) Distinguish between the fork lengths of *O. nerka* in autumn 2008 and winter 2009. [2]

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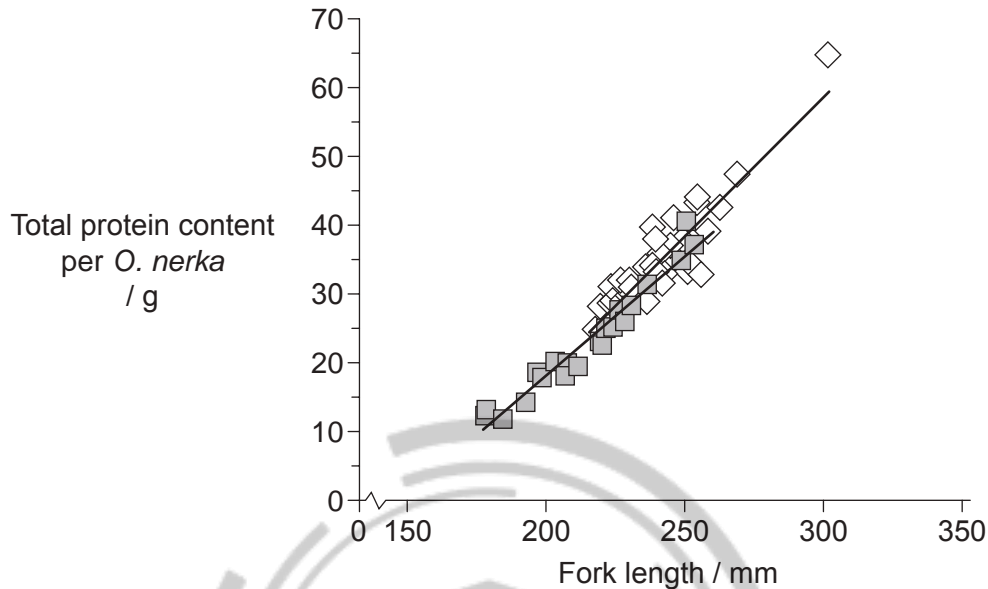
- (c) Suggest a reason for the variation in fork length of ocean age one *O. nerka*. [1]

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(This question continues on the following page)

(Question 1 continued)

Protein content in *O. nerka* was measured to evaluate possible differences during their first 15 months at sea. The graph shows the relationship between fork length and total protein content per *O. nerka* caught during autumn 2008 and winter 2009.



Key: ■ autumn 2008 (juvenile *O. nerka*) ◇ winter 2009 (ocean age one *O. nerka*)

[Source: Adapted from Edward V. Farley, Alexander Starovoytov, Svetlana Naydenko, Ron Heintz, Marc Trudel, Charles Guthrie, Lisa Eisner and Jeffrey R. Guyon (2011) 'Implications of a warming eastern Bering Sea for Bristol Bay sockeye salmon'. *ICES Journal of Marine Science*, 68 (6), pages 1138–1146, by permission of Oxford University Press.]

- (d) (i) Compare the protein content for *O. nerka* caught during autumn 2008 and winter 2009. [2]

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- (ii) Outline the difficulty in predicting the age of *O. nerka* from fork length. [1]

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(This question continues on the following page)



(Question 1 continued)

- (e) Using the data, suggest **one** reason for the relationship between protein content and fork length.

[1]

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(This question continues on the following page)



(Question 1 continued)

(f) Scientists measured mercury levels in different fish. The table shows the results.

	Mercury / $\mu\text{g g}^{-1}$				Number of samples
	Mean	Standard deviation	Minimum	Maximum	
Cod	0.111	0.066	0.001	0.989	115
Monkfish	0.181	0.075	0.056	0.289	9
Shark	0.979	0.626	0.001	4.540	356
Trout	0.071	0.025	0.001	0.678	35

(i) Compare the results shown in the table for monkfish and shark. [2]

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(ii) Suggest additional information that would be helpful in evaluating these data. [1]

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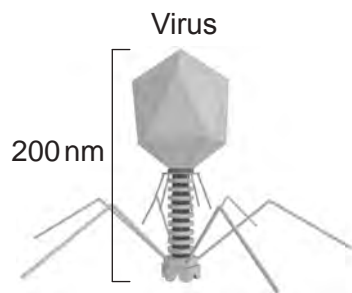
(g) State which type of fish shows the most variation. [1]

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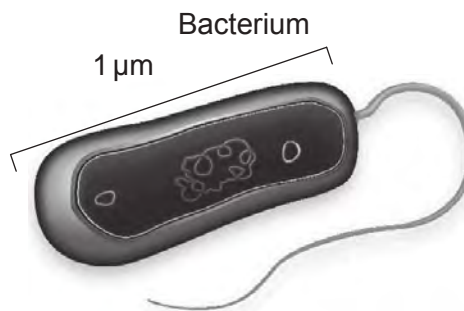
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2. The diagrams show a virus and a bacterium.



[Source: Adapted from <http://cronodon.com>. Used with permission.]



[Source: Image courtesy of the Microbiology Society.]

(a) Calculate the magnification of the bacterium. [1]

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(b) State the method that bacteria use to divide. [1]

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(This question continues on the following page)

(Question 2 continued)

- (c) Outline the effectiveness of antibiotics against viruses and bacteria. [1]

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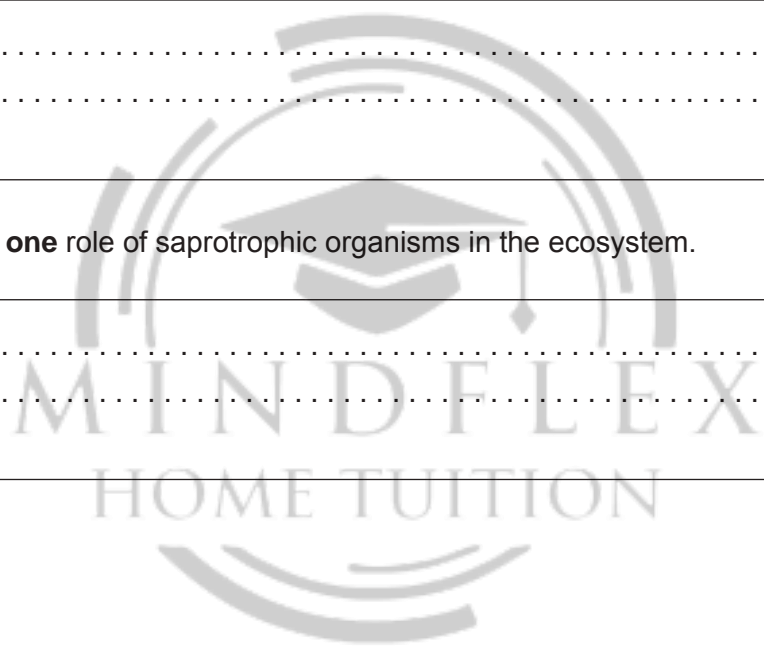
- (d) Saprotrophic organisms, such as *Mucor* species, are abundant in soils.

- (i) Define *saprotrophic organisms*. [1]

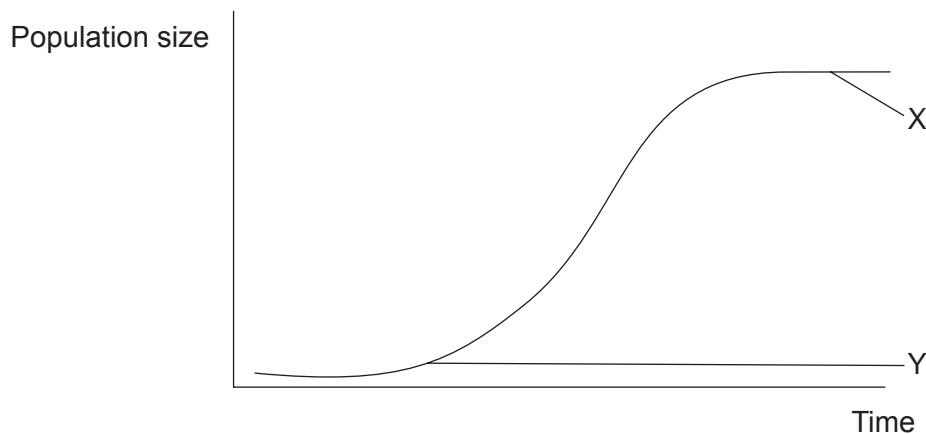
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- (ii) State **one** role of saprotrophic organisms in the ecosystem. [1]

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3. The graph shows a sigmoid population growth curve.



(a) Identify the phases labelled X and Y. [1]

X:
Y:

(b) Outline how fossil records can provide evidence for evolution. [2]

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(This question continues on the following page)

(Question 3 continued)

(c) The table summarizes the genome size of several organisms.

Organism type	Organism	Genome size / base pairs
Bacterium	<i>Helicobacter pylori</i>	1 667 867
Fruit fly	<i>Drosophila melanogaster</i>	130 000 000
Rice	<i>Oryza sativa</i>	420 000 000
Human	<i>Homo sapiens</i>	3 200 000 000

(i) Distinguish between the terms genotype and phenotype. [1]

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(ii) Outline a structural difference between the chromosomes of *Helicobacter pylori* and *Homo sapiens*. [1]

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(iii) Deduce the percentage of adenine in *Oryza sativa* if the proportion of guanine in that organism is 30%. [1]

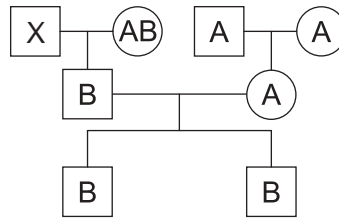
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(Question 3 continued)

(d) The figure shows a pedigree chart for the blood groups of three generations.

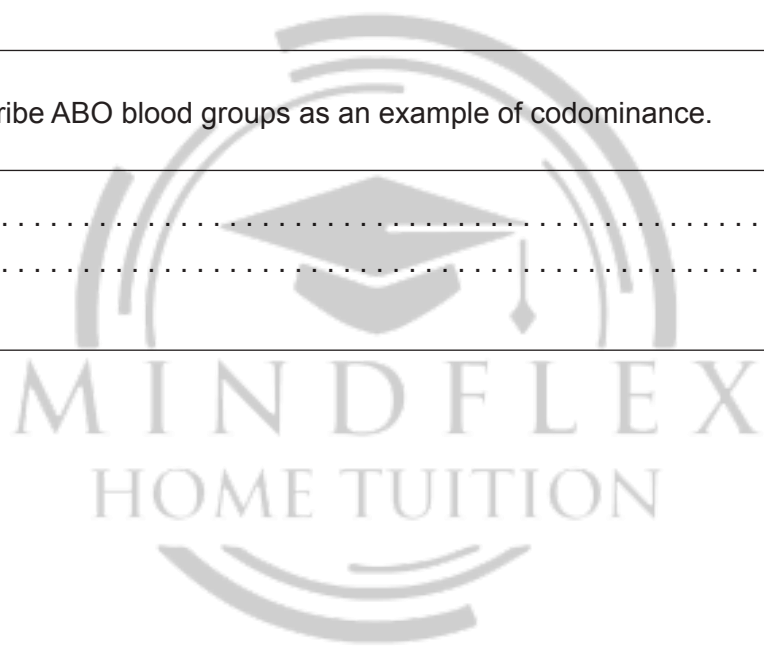


(i) Deduce the possible phenotypes of individual X. [1]

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(ii) Describe ABO blood groups as an example of codominance. [1]

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4. (a) Draw a labelled diagram showing the **interconnections** between the liver, gall bladder, pancreas and small intestine. [2]

- (b) Outline the role of glucagon in homeostasis of glucose. [2]

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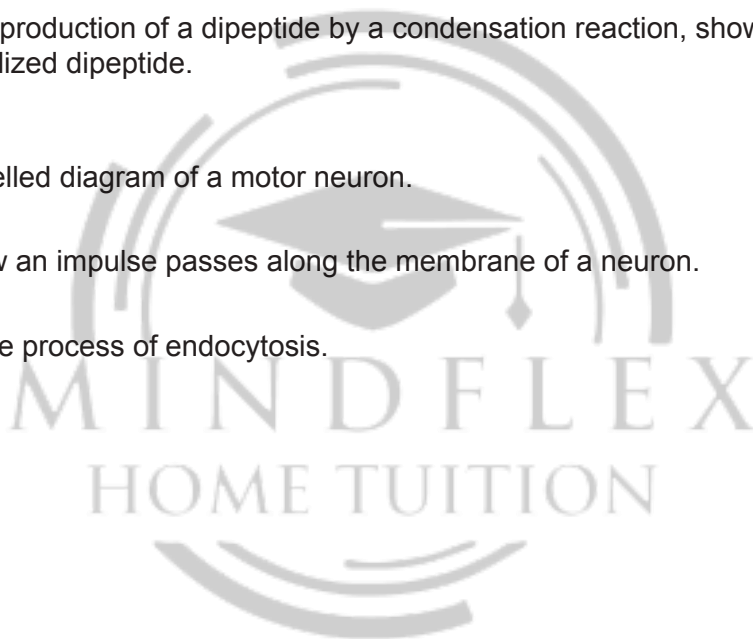
- (c) List **two** examples of polysaccharides. [1]

1.
2.

Section B

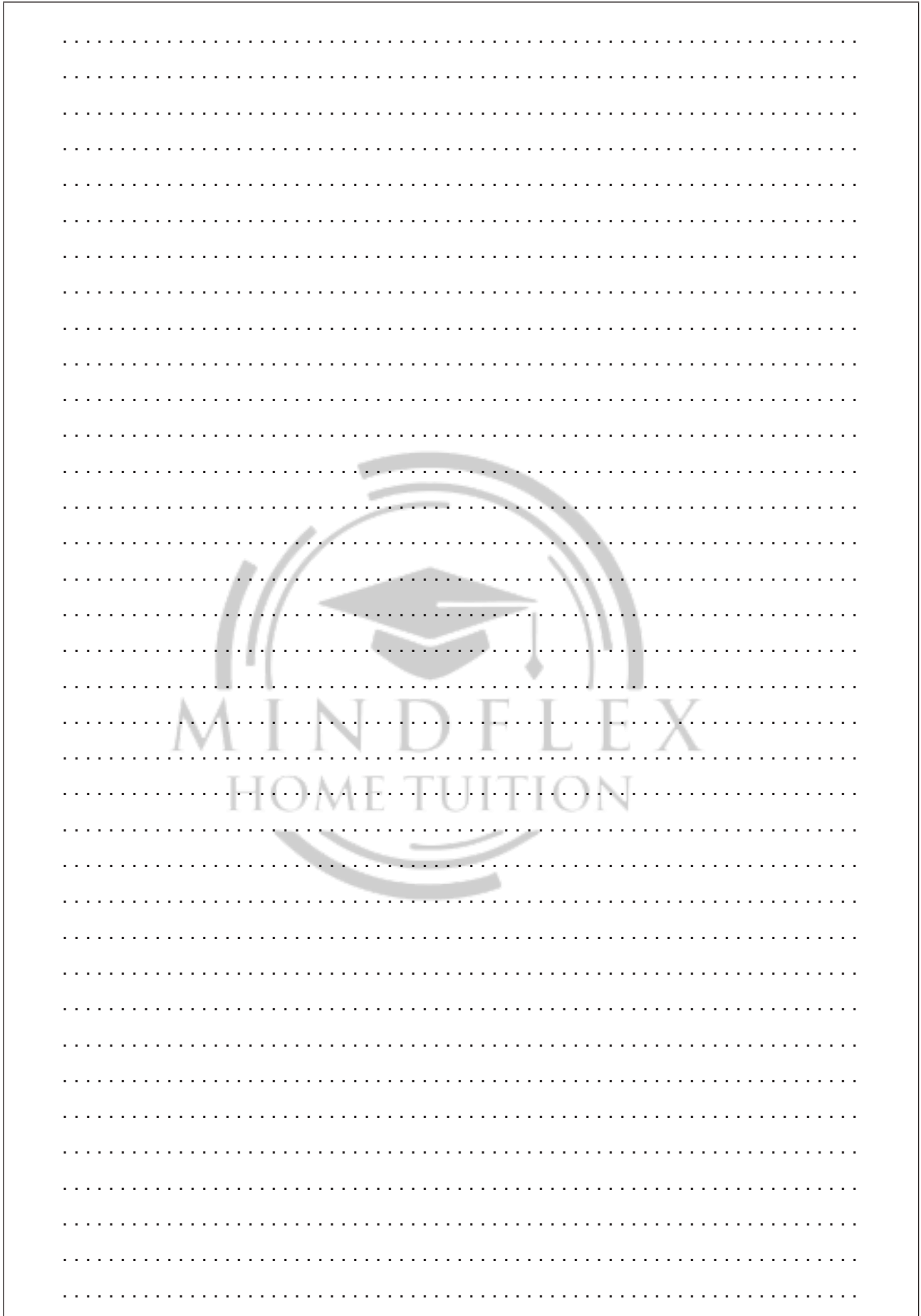
Answer **one** question. Up to two additional marks are available for the construction of your answer.
Write your answers in the boxes provided.

5. (a) Draw a labelled diagram of a section of DNA showing four nucleotides. [5]
- (b) Outline a technique used for gene transfer. [5]
- (c) Explain how evolution may happen in response to an environmental change. [8]
6. (a) Outline the stages of the cell cycle. [5]
- (b) Explain the process of translation in cells. [8]
- (c) Outline the production of a dipeptide by a condensation reaction, showing the structure of a generalized dipeptide. [5]
7. (a) Draw a labelled diagram of a motor neuron. [5]
- (b) Explain how an impulse passes along the membrane of a neuron. [8]
- (c) Describe the process of endocytosis. [5]



A large rectangular area containing horizontal dotted lines for writing, with a faint watermark logo in the center. The watermark logo features a graduation cap inside a circular frame, with the text "MINDFLEX HOME TUITION" below it.





A large rectangular area containing horizontal dotted lines for writing. A faint watermark logo is centered in the middle of this area. The logo features a graduation cap (mortarboard) inside a circular frame with curved lines, and the text "MIND FLEX HOME TUITION" below it.



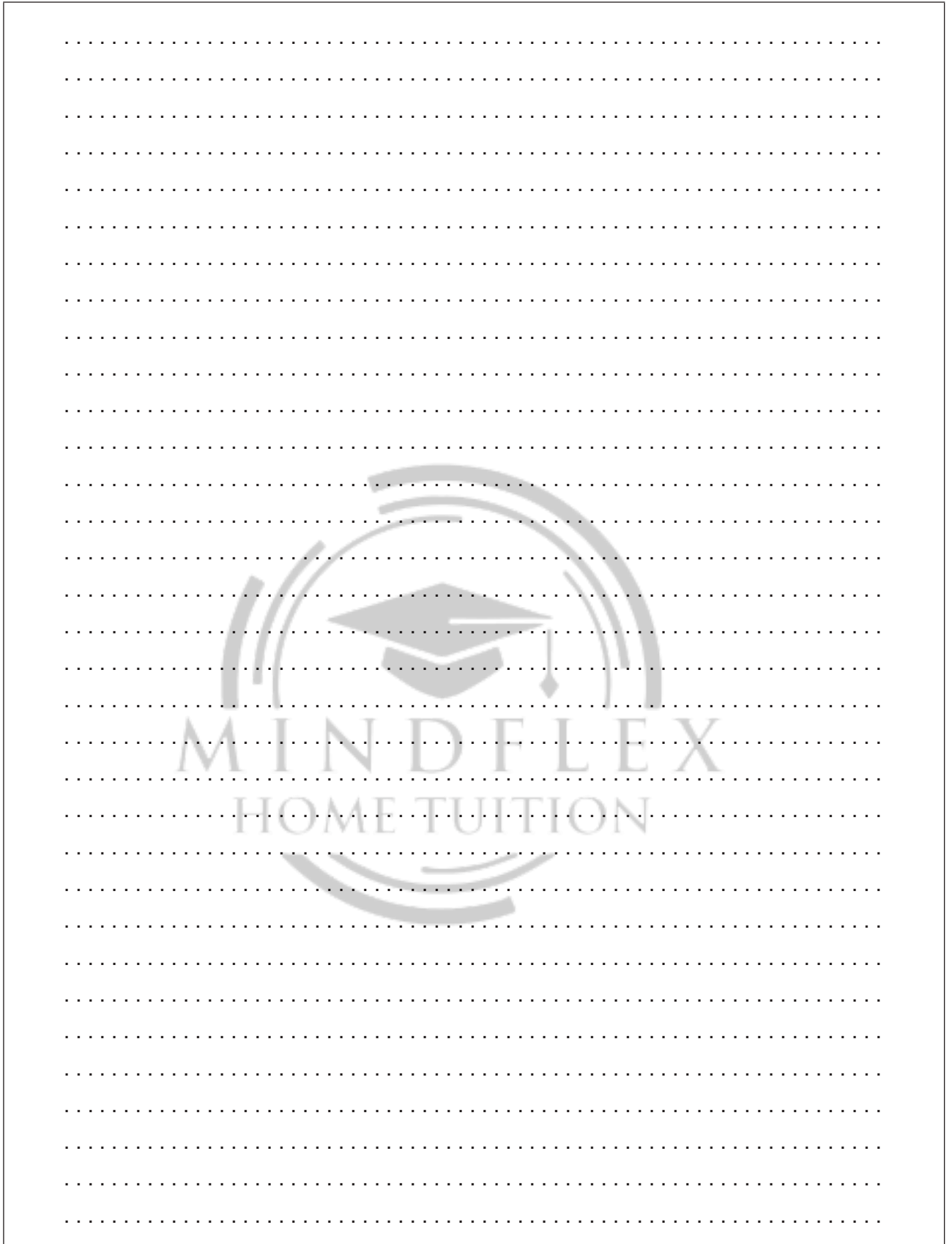


A large rectangular area containing horizontal dotted lines for writing. A watermark logo is centered on the page, featuring a graduation cap inside a circular design with the text "MINDFLEX HOME TUITION" below it.



A large rectangular area containing horizontal dotted lines for writing, with a faint watermark logo in the center. The watermark consists of a graduation cap inside a circular frame, with the text 'MIND FLEX HOME TUITION' below it.





Biology
Standard level
Paper 3

Friday 6 November 2015 (afternoon)

Candidate session number

1 hour

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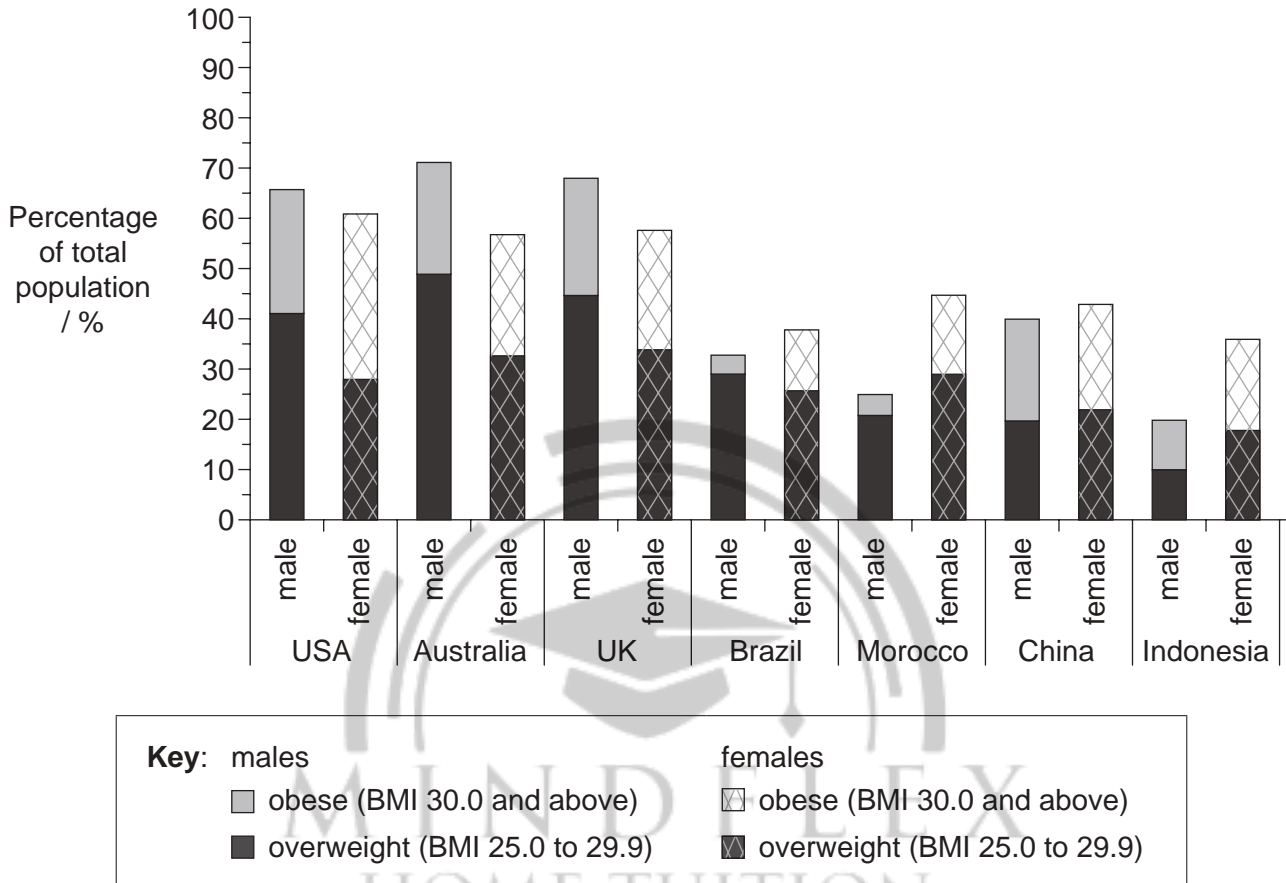
Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the options.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[36 marks]**.

Option	Questions
Option A — Human nutrition and health	1 – 3
Option B — Physiology of exercise	4 – 6
Option C — Cells and energy	7 – 9
Option D — Evolution	10 – 12
Option E — Neurobiology and behaviour	13 – 15
Option F — Microbes and biotechnology	16 – 18
Option G — Ecology and conservation	19 – 21

Option A — Human nutrition and health

1. Nationally representative data was collected on body mass index (BMI) from 1985 to 2004. The graph shows overweight and obesity patterns in adult males and females from seven countries.



[Source: Republished with permission of the American Society for Nutrition, from B. Popkin (2006) *American Journal of Clinical Nutrition*, **84**, pages 289–298; permission conveyed through Copyright Clearance Center, Inc.]

- (a) State which country has the lowest total percentage of overweight and obese adults. [1]

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(Option A continues on the following page)

(Option A, question 1 continued)

- (b) Distinguish between the levels of male obesity and female obesity. [2]

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- (c) Compare the overweight and obesity patterns in Australia and Morocco. [2]

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- (d) Suggest **two** possible reasons for the differences in BMI from the reported countries. [2]

1.
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2.
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(Option A continues on the following page)

(Option A continued)

2. (a) List **two** natural food sources of vitamin D in human diets. [1]

1.
2.

- (b) Discuss how the risk of vitamin D deficiency from insufficient exposure to sunlight can be balanced against overexposure. [3]

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(Option A continues on the following page)



(Option A continued)

3. (a) In the past, food companies have promoted artificial milk over breastfeeding. Distinguish between the composition of artificial milk used for bottle-feeding babies and human milk. [2]

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- (b) Explain the possible health consequences of a high fat diet. [3]

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- (c) The recommended intake of vitamin C was determined by experiments involving humans and small mammals. Outline the role of animal testing in determining the recommended levels of vitamin C. [2]

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End of Option A

Option B — Physiology of exercise

4. Creatine supplementation has been marketed to athletes as a way of enhancing performance. Following a control trial, nine competitive male cyclists were randomly assigned to receive either a creatine or placebo supplement. The cyclists then rode for 5 kilometers at a set intensity and sprinted the last 200 meters. This sequence was repeated five times without stopping. The table shows the effect of creatine supplementation (+creatine) on sprint time, heart rate and VO_2 max. Values are mean \pm standard deviation.

	Sprint 1	Sprint 2	Sprint 3	Sprint 4	Sprint 5
Sprint time / seconds					
Control	17.05 \pm 0.92	17.46 \pm 0.59	17.77 \pm 0.52	18.24 \pm 1.00	18.21 \pm 1.11
Placebo	17.20 \pm 0.64	17.53 \pm 0.61	17.93 \pm 0.77	18.47 \pm 0.74	18.34 \pm 0.97
+Creatine	16.92 \pm 1.03	17.45 \pm 1.05	17.86 \pm 1.11	18.06 \pm 0.97	18.18 \pm 1.45
Heart rate / b min⁻¹					
Control	163 \pm 08	167 \pm 08	169 \pm 08	172 \pm 06	169 \pm 08
Placebo	163 \pm 09	167 \pm 10	168 \pm 08	168 \pm 09	170 \pm 08
+Creatine	165 \pm 10	167 \pm 08	168 \pm 05	168 \pm 08	169 \pm 11
VO_2 max / dm³ min⁻¹					
Control	4.24 \pm 0.20	4.33 \pm 0.28	4.20 \pm 0.40	4.14 \pm 0.41	4.03 \pm 0.47
Placebo	4.18 \pm 0.38	4.16 \pm 0.53	4.17 \pm 0.54	3.98 \pm 0.64	4.00 \pm 0.62
+Creatine	4.19 \pm 0.33	4.30 \pm 0.40	4.14 \pm 0.42	4.04 \pm 0.36	4.03 \pm 0.47

[Source: D. Levesque *et al.* 'Creatine Supplementation: Impact on Cycling Sprint Performance' (2007)
Journal of Exercise Physiology online, **10** (4)]

- (a) State which sprint was completed in the least amount of time. [1]

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(Option B continues on the following page)



(Option B, question 4 continued)

- (b) Calculate the difference in VO_2 max between the control mean and +creatine in sprint 4, giving the units. [1]

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- (c) Outline the effect of placebo and +creatine treatments on heart rate during the trials. [2]

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- (d) Define VO_2 max. [1]

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- (e) Evaluate the data regarding the hypothesis that creatine supplementation enhances athletic performance. [2]

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(Option B continues on the following page)

(Option B continued)

5. (a) Draw a labelled diagram showing the arrangement of proteins in a sarcomere. [3]



- (b) Distinguish between fast muscle fibres and slow muscle fibres. [2]

(Option B continues on the following page)



(Option B continued)

6. (a) Outline the method of ATP production used by muscle fibres during exercise of varying intensity and duration. [3]

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- (b) Discuss the possible benefits of warm-up routines. [3]

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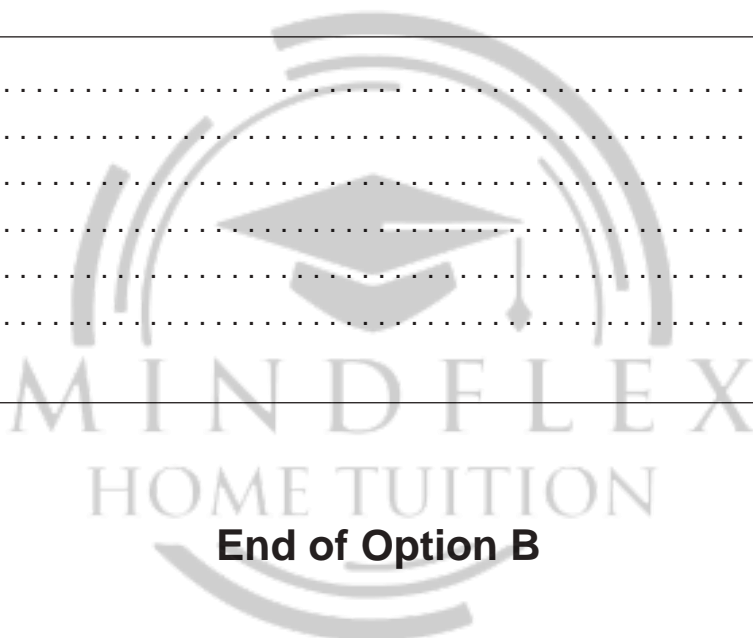
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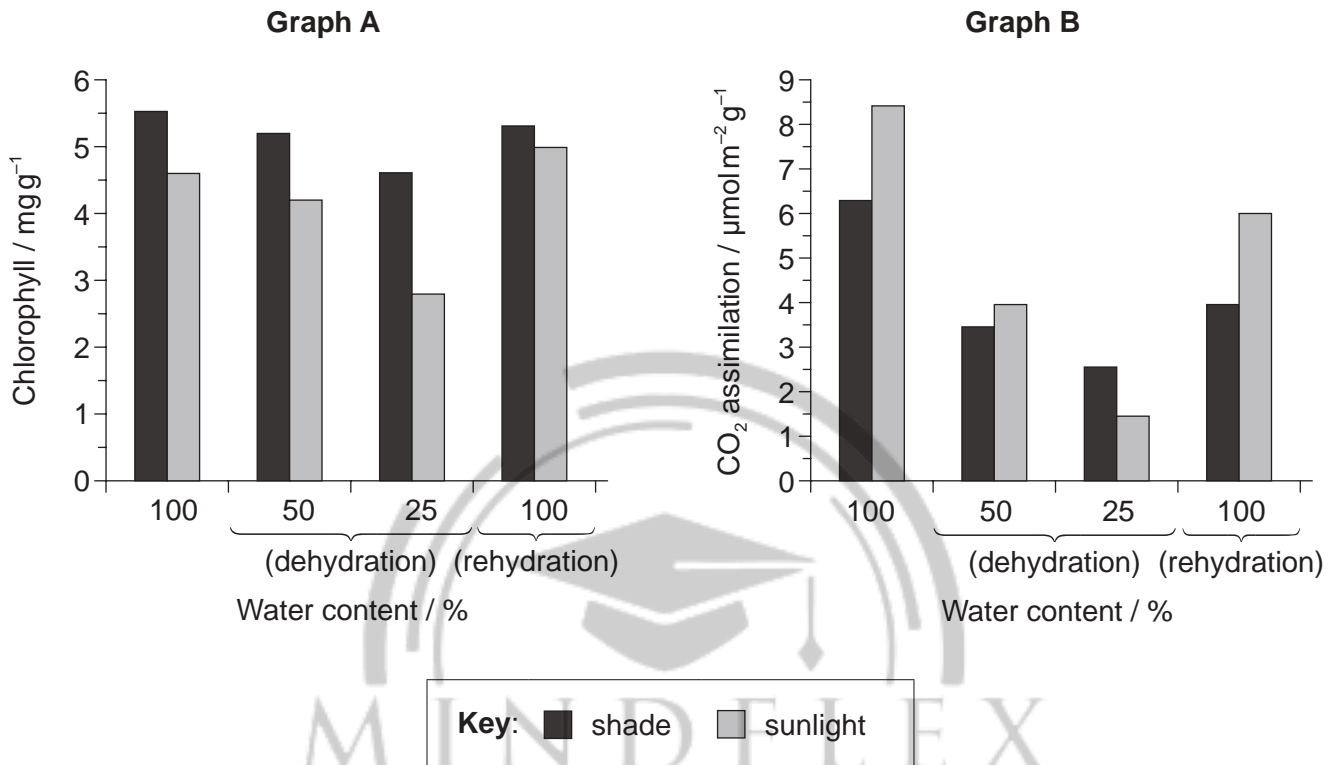


End of Option B



Option C — Cells and energy

7. The *Haberlea rhodopensis* plant is capable of tolerating extreme dryness. Chlorophyll levels and CO₂ assimilation were evaluated during dehydration and rehydration using plants grown in shade and sunlight. Graph A shows the changes in chlorophyll content with increasing dehydration and during rehydration. Graph B shows the changes in CO₂ assimilation with increasing dehydration and during rehydration.



[Source: adapted from K Georgieva, et al., (2013), 15th International Conference on Photosynthesis, pages 536–542]

(a) State the level of chlorophyll at 50% water content for plants growing in sunlight, giving the units.

[1]

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(Option C continues on the following page)



(Option C, question 7 continued)

- (b) Outline the effect of sunlight and shade on CO₂ assimilation during dehydration. [2]

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- (c) Compare the effect of rehydration on chlorophyll levels in plants grown in shade and sunlight. [2]

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- (d) Using the data, deduce, with a reason, **two** stages of photosynthesis that may be limited during dehydration in a plant. [2]

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(Option C continued)

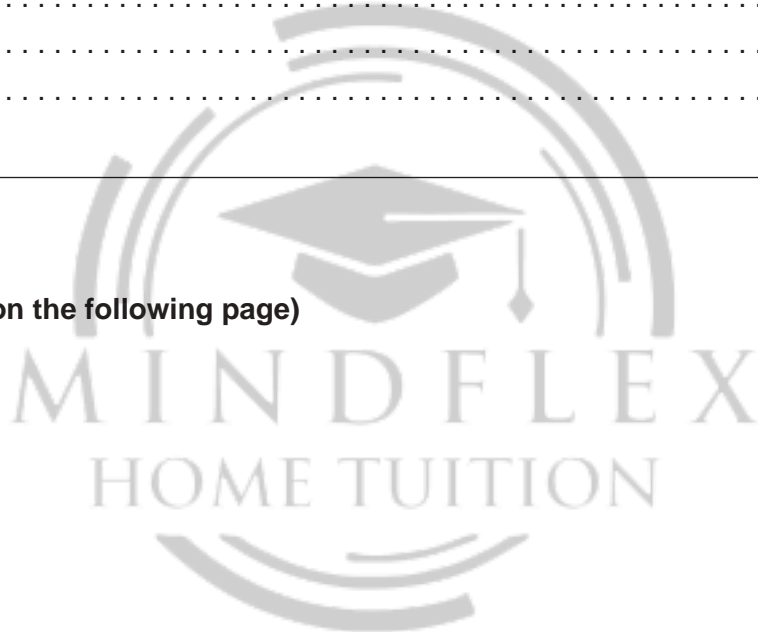
8. (a) State **one** difference in function between fibrous proteins and globular proteins. [1]

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- (b) Describe the induced-fit model of enzyme action. [3]

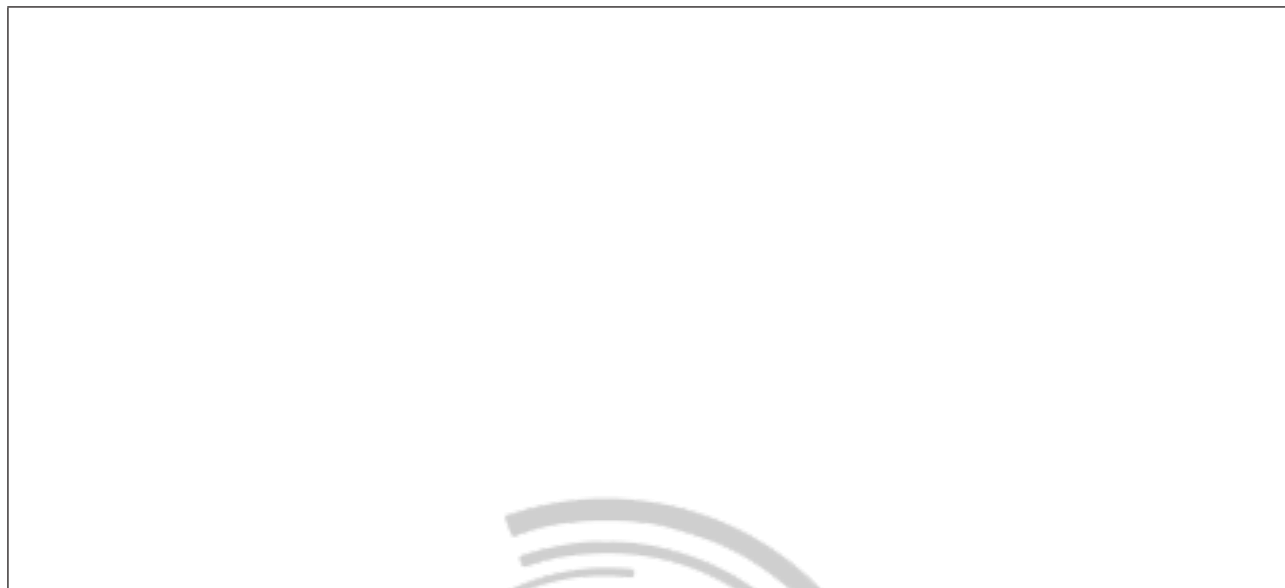
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(Option C continued)

9. (a) Draw a labelled diagram showing the structure of a chloroplast. [3]



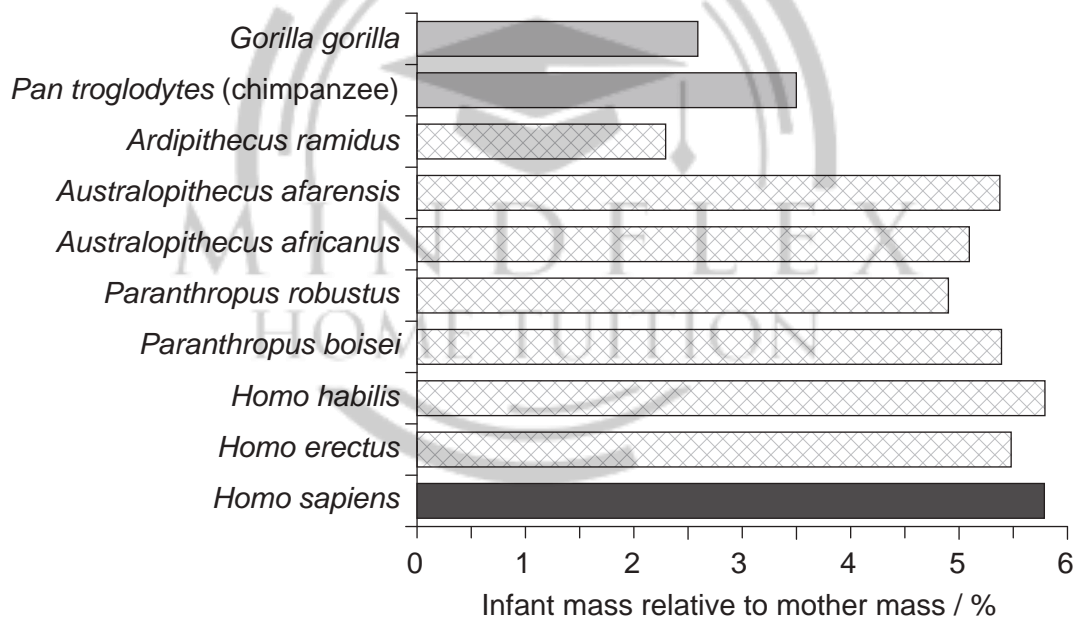
- (b) Explain how energy is released and used to make ATP by electron carriers in the electron transport chain during aerobic respiration. [4]



End of Option C

Option D — Evolution

10. Modern human mothers give birth to proportionately larger infants than apes do, but it is not clear when this change occurred over the course of human evolution. The graph shows the infant mass relative to mother mass in primates, extinct hominids and modern humans.



Key: ■ non-hominid primates ▨ extinct hominids ■ modern humans

[Source: Text: *PNAS*, 2011, vol. **108** (3), 1022–1027, Figure 2
<http://www.pnas.org/content/108/3/1022.full>

Photo: "Chimpanzee mom and baby cropped" by Original uploader was Steve from Flickr, modified by The High Fin Sperm Whale (talk) - baby chimp. Licensed under CC BY-SA 2.0 via Commons - https://commons.wikimedia.org/wiki/File:Chimpanzee_mom_and_baby_cropped.jpg#/media/File:Chimpanzee_mom_and_baby_cropped.jpg

(Option D continues on the following page)



(Option D, question 10 continued)

- (a) State the infant mass relative to mother mass of *Homo sapiens*. [1]

..... %

- (b) Outline the difference in infant mass relative to mother mass in extinct hominids and modern humans. [1]

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- (c) Suggest a hypothesis, based on evidence in the data, for when the shift to giving birth to larger infants occurred in the evolution of humans. [2]

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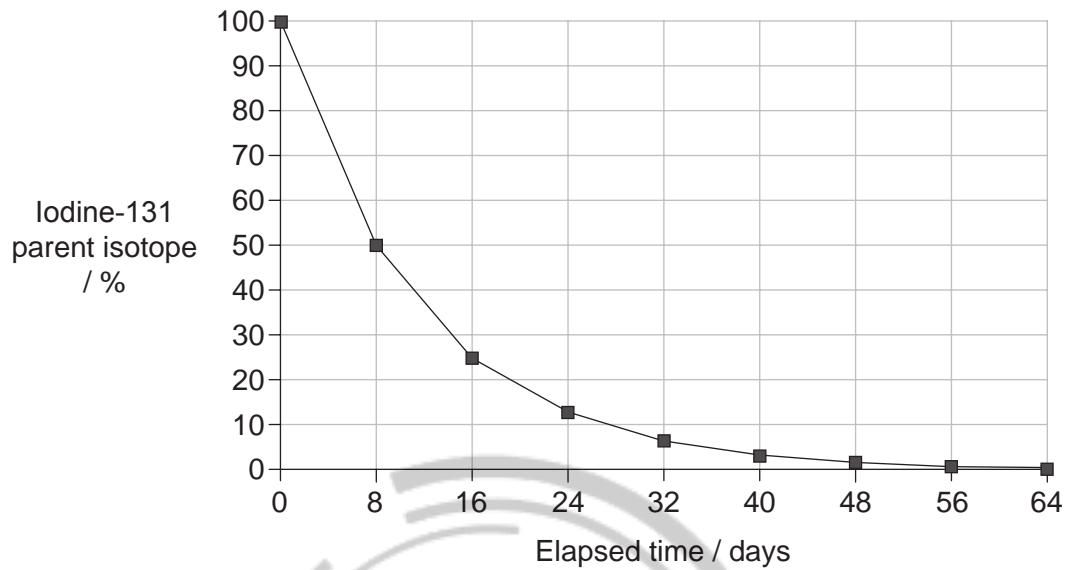
- (d) Suggest **one** disadvantage of infants being born with a relatively large size in humans. [1]

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(Option D continues on the following page)

(Option D continued)

11. (a) Radioactive iodine-131 is leaking into the Pacific Ocean from the damaged Fukushima Number One Power Plant. The graph shows the decay curve of iodine-131.



Deduce the half-life of iodine-131 from the decay curve, giving the units. [1]

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- (b) State an example of balanced polymorphism. [1]

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(Option D continues on the following page)



(Option D, question 11 continued)

(c) Compare convergent and divergent evolution.

[3]

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(Option D continues on the following page)



(Option D continued)

12. (a) There is evidence that prokaryotes were responsible for changes in the atmospheric gases 3.5 billion years ago. Outline the role of bacteria in producing an oxygen-rich atmosphere. [3]

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- (b) Discuss the evidence supporting the endosymbiotic theory for the origin of eukaryotes. [3]

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- (c) Gaining popularity in the early 21st century, the Paleolithic diet recommends following a similar diet to the ancient hunter-gatherers. Outline the correlation between the change in diet and increase in brain size during hominid evolution. [2]

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End of Option D



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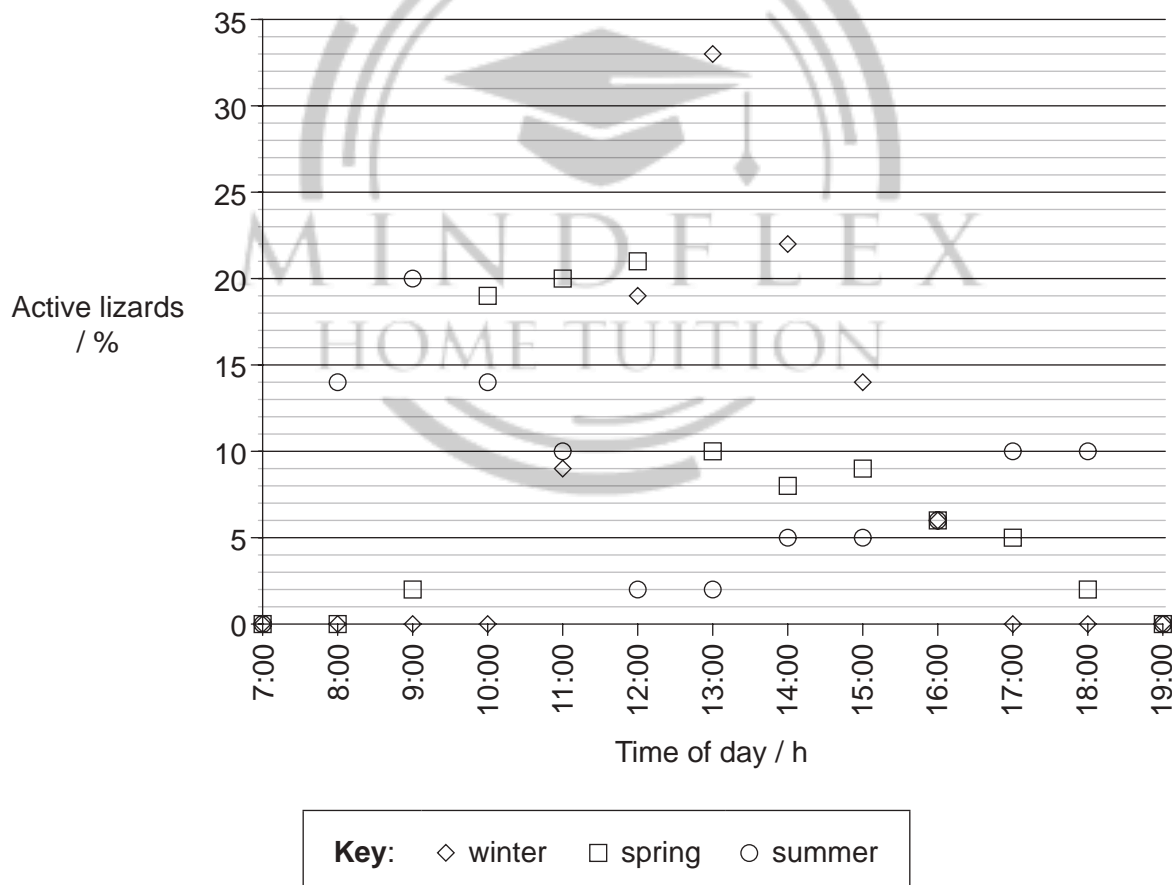


Option E — Neurobiology and behaviour

13. Lizards living in the Kalahari Desert of southern Africa are diurnal (active in daylight). Scientists studied this rhythmical behaviour during different seasons of the year. Observations were made of the number of lizards active each hour and this was recorded as a percentage of the total number of lizards that were active. The graph shows the results for the Southern Spiny Agama (*Agama hispida*) lizard. Between the hours of 19:00 and 7:00 the lizards were inactive.



[Source: Image courtesy of Trevor Hardaker. www.hardaker.co.za]



[Source: R. B. Huey and E. P. Pianka (1977) *Ecology*, **58** (5), pages 1066–1075.]

(Option E continues on the following page)



(Option E, question 13 continued)

- (a) State **one** time in spring when 5% of the lizards were active. [1]

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- (b) (i) Winter and summer weather conditions differ in the Kalahari Desert. Compare the results for summer and winter. [3]

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- (ii) The temperatures differ in summer and winter. Suggest **one** other possible reason why the lizard activity differs in summer and winter. [1]

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- (c) The body temperature of the lizard is similar to environmental temperature. State the type of receptors that could detect changes in external temperature. [1]

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(Option E continues on the following page)

(Option E continued)

14. (a) Draw a labelled diagram of a reflex arc for a pain withdrawal reflex. [4]



- (b) Distinguish between innate behaviour and learned behaviour. [3]



(Option E continues on the following page)



(Option E continued)

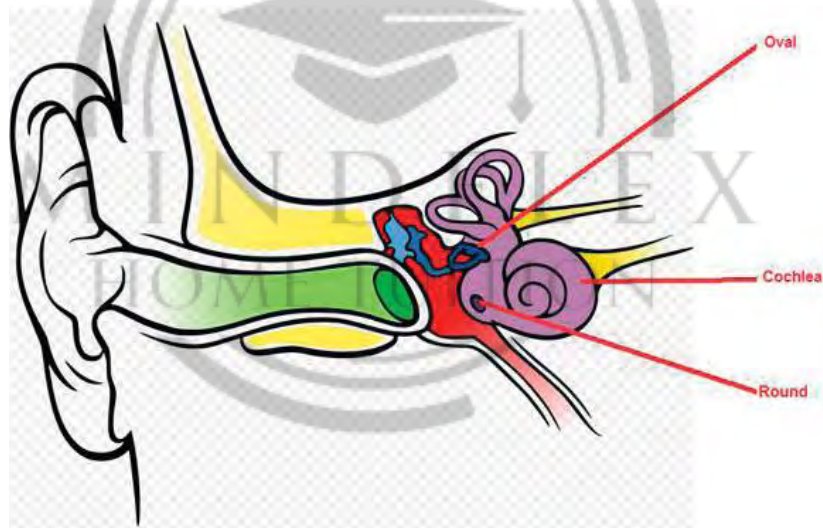
15. (a) Identify the type of retinal cells that function best in dim light. [1]

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- (b) Explain how cocaine affects synaptic transmission at synapses in the brain. [3]

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- (c) The image shows the human ear.



[Source: "Anatomy of the Human Ear blank" by Anatomy_of_the_Human_Ear.svg: Chittka L, Brockmann derivative work: M•Komorniczak -talk- - Anatomy_of_the_Human_Ear.svg. Licensed under CC BY 2.5 via Wikimedia Commons - https://commons.wikimedia.org/wiki/File:Anatomy_of_the_Human_Ear_blank.svg#/media/File:Anatomy_of_the_Human_Ear_blank.svg]

- Outline the role of the round window in the perception of sound. [1]

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End of Option E

Option F — Microbes and biotechnology

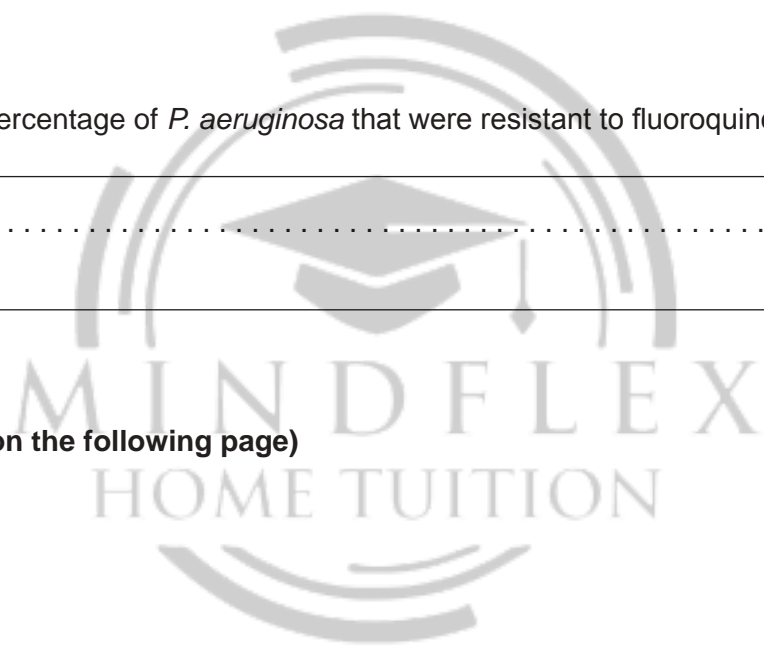
16. Data on microbial resistance to the fluoroquinolone family of antibiotics was collected in US hospitals. The graph shows the relationship between *Pseudomonas aeruginosa*, other Gram-negative bacteria and the use of fluoroquinolone from 1993 to 2000.

Graph removed for copyright reasons

- (a) State the percentage of *P. aeruginosa* that were resistant to fluoroquinolone in 1996. [1]

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(Option F continues on the following page)



(Option F, question 16 continued)

- (b) Compare the trends in fluoroquinolone use and resistance to fluoroquinolone in other Gram-negative bacteria between 1993 and 2000. [2]

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- (c) Predict the results if data from the same hospitals were collected for *P. aeruginosa* resistance in 2001. [1]

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- (d) Discuss the implications of the data in the graph for the health of patients. [3]

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(Option F continued)

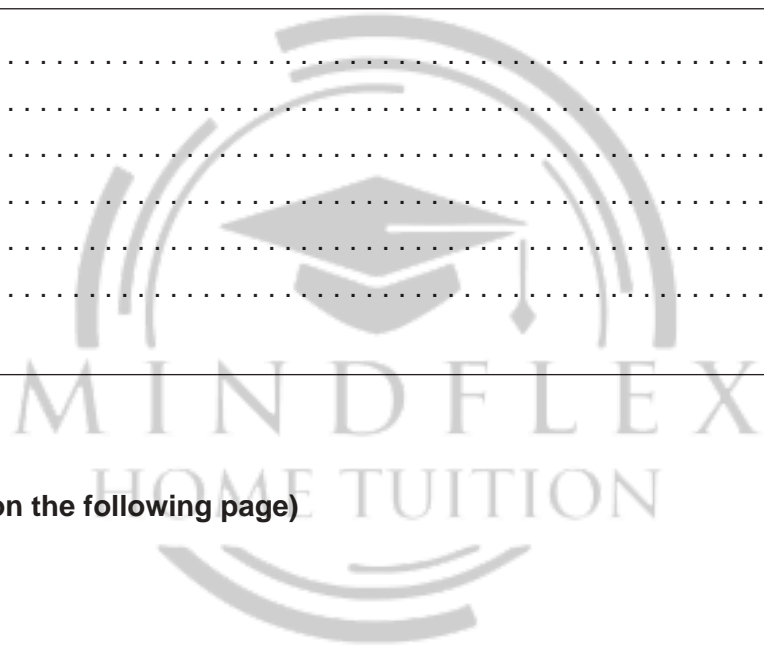
17. (a) Distinguish between the characteristics of eubacteria and eukaryotes. [3]

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- (b) Outline the process of nitrogen fixation by a **named** free-living bacterium. [2]

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(Option F continues on the following page)



(Option F continued)

18. (a) Improper food preparation can lead to food poisoning. State **one** recommended treatment for a **named** example of food poisoning. [2]

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- (b) Researchers are studying several ways to treat cancer using gene therapy. Discuss the risks of gene therapy. [4]

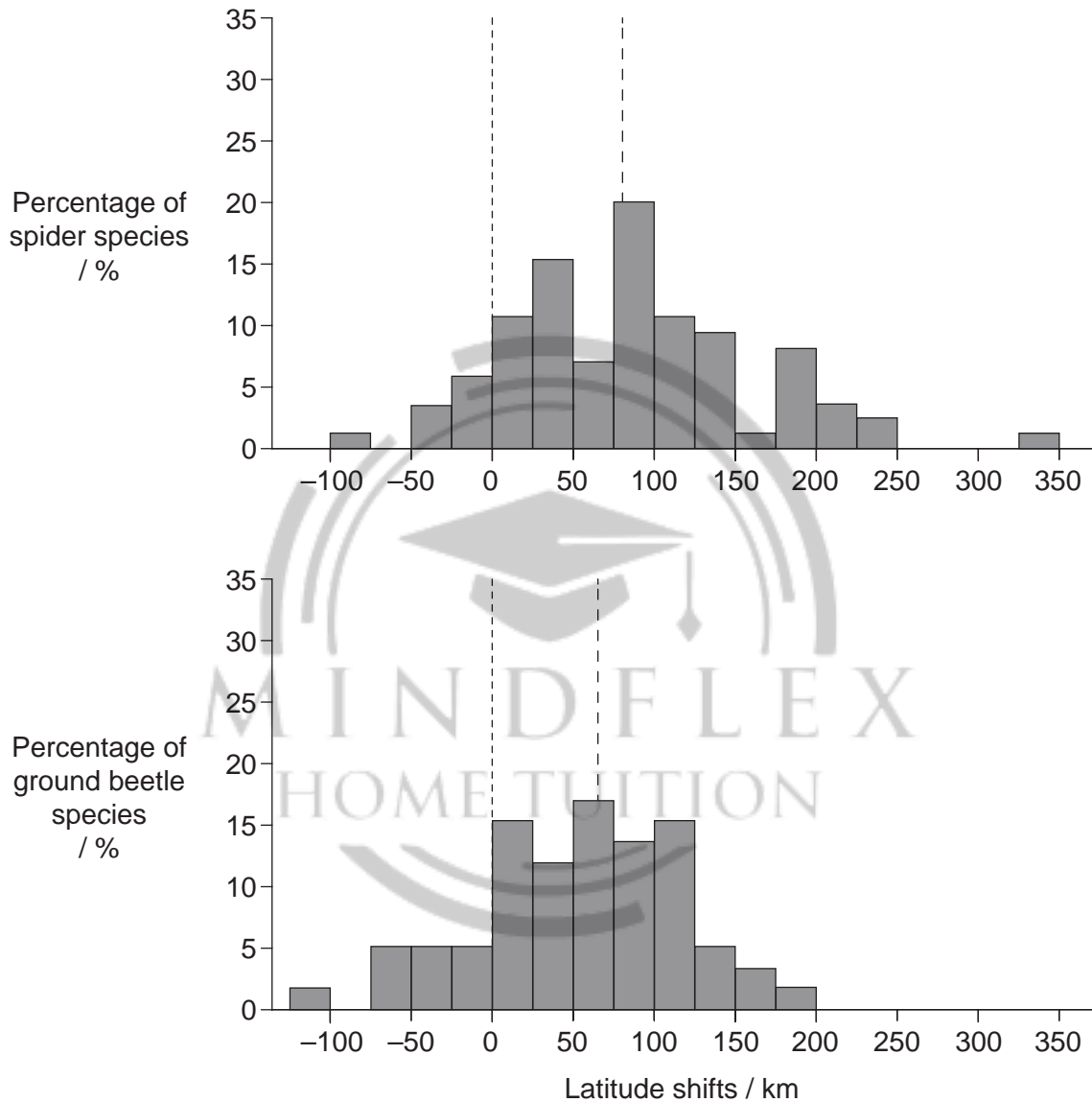
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End of Option F

Option G — Ecology and conservation

19. The distributions of many terrestrial organisms are currently shifting in latitude in response to changing climate. The graph shows the latitudinal shifts of the northern range boundaries of species within two taxonomic groups that were observed over 25 years in Britain. Positive latitudinal shifts indicate that a species now inhabits areas further to the north than it did before and negative shifts indicate that the northern edge of the range has moved south.



Key: - - - - - zero shift - - - - - median shift

[Source: I-Ching Chen, Jane K. Hill, Ralf Ohlemüller, David B. Roy, and Chris D. Thomas. “Rapid Range Shifts of Species Associated with High Levels of Climate Warming” (2011) *Science*, **333** (6045), pages 1024–1026. Reprinted with permission from AAAS. Readers may view, browse, and/or download material for temporary copying purposes only, provided these uses are for noncommercial personal purposes. Except as provided by law, this material may not be further reproduced, distributed, transmitted, modified, adapted, performed, displayed, published, or sold in whole or in part, without prior written permission from the publisher.]

(Option G continues on the following page)



(Option G, question 19 continued)

- (a) State which taxonomic group shows the greatest median shift. [1]

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- (b) Calculate the percentage of ground beetles that are below the zero shift. [1]

.....%

- (c) Compare the changes in the range of ground beetles with the changes in the range of spiders. [2]

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- (d) Spiders and ground beetles are both predators. Discuss possible effects on other species resulting from the latitudinal shift of the predators. [2]

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- (e) Suggest **one** possible cause for the disappearance of some species from the northerly areas of their range. [1]

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(Option G continues on the following page)

(Option G continued)

20. (a) Define *biomass*. [1]

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- (b) Explain how living organisms can change the abiotic environment during primary succession. [3]

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- (c) (i) Distinguish between the biosphere and biomes. [1]

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- (ii) Outline the typical yearly temperatures and vegetation found in a **named** biome. [2]

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(Option G continues on the following page)



(Option G continued)

21. (a) State the process where pesticides such as DDT become more concentrated at each trophic level. [1]

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- (b) Explain what is meant by the niche concept. [3]

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End of Option G

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