

Biology
Standard level
Paper 3

Friday 6 November 2015 (afternoon)

Candidate session number

1 hour

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Instructions to candidates

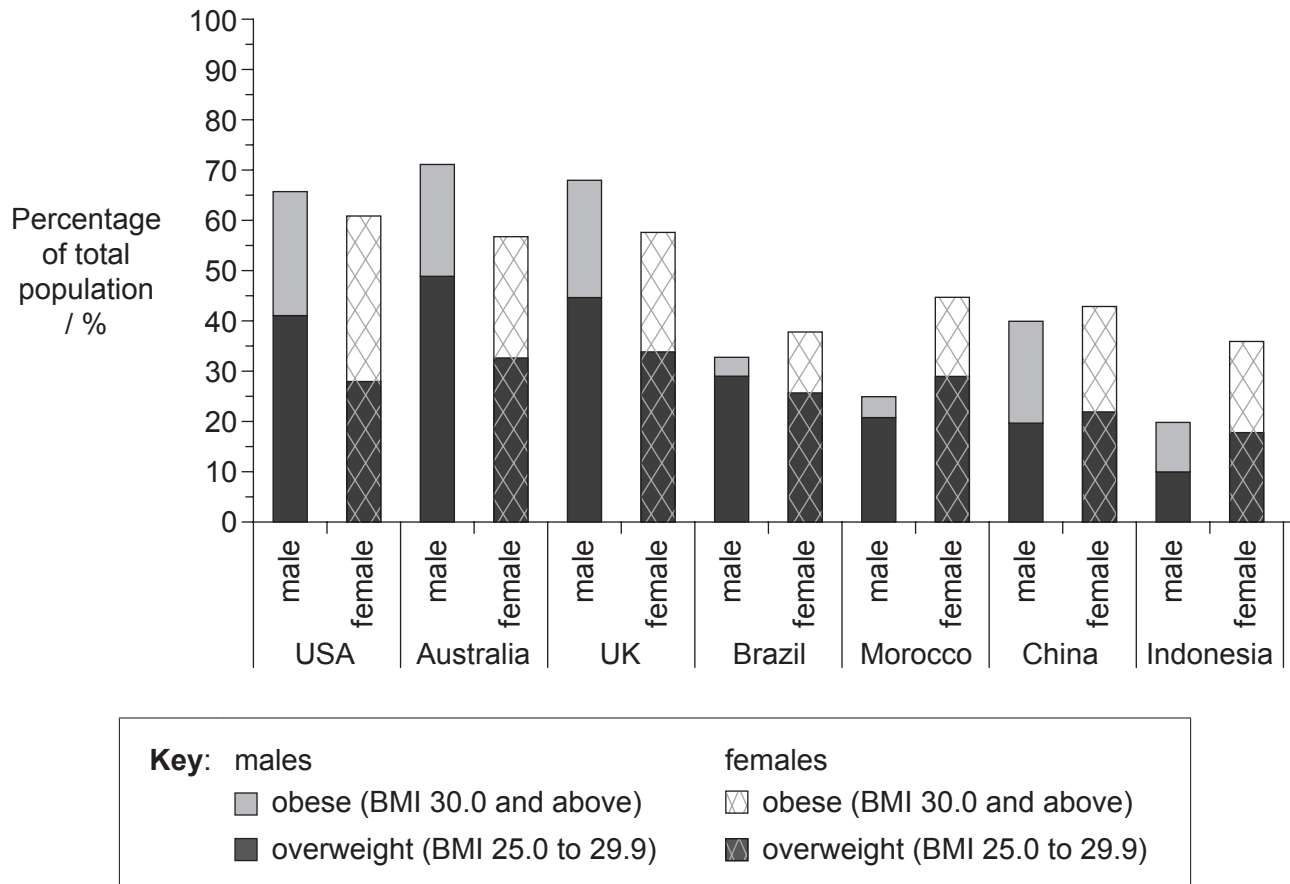
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the options.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is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

Option	Questions
Option A — Human nutrition and health	1 – 3
Option B — Physiology of exercise	4 – 6
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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]

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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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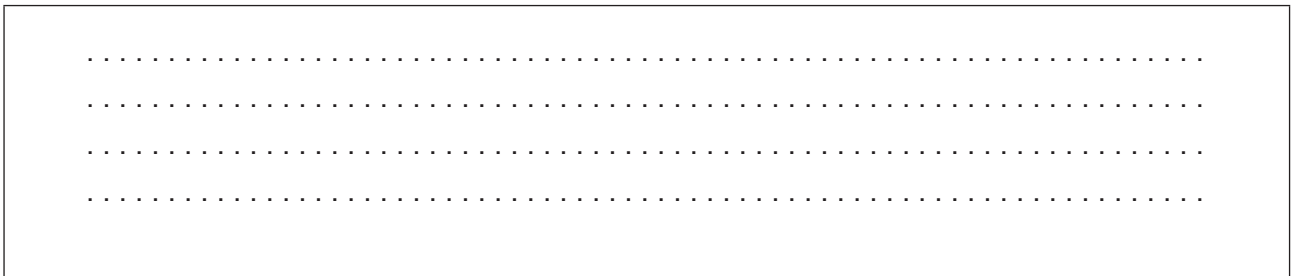


(Option B continued)

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]

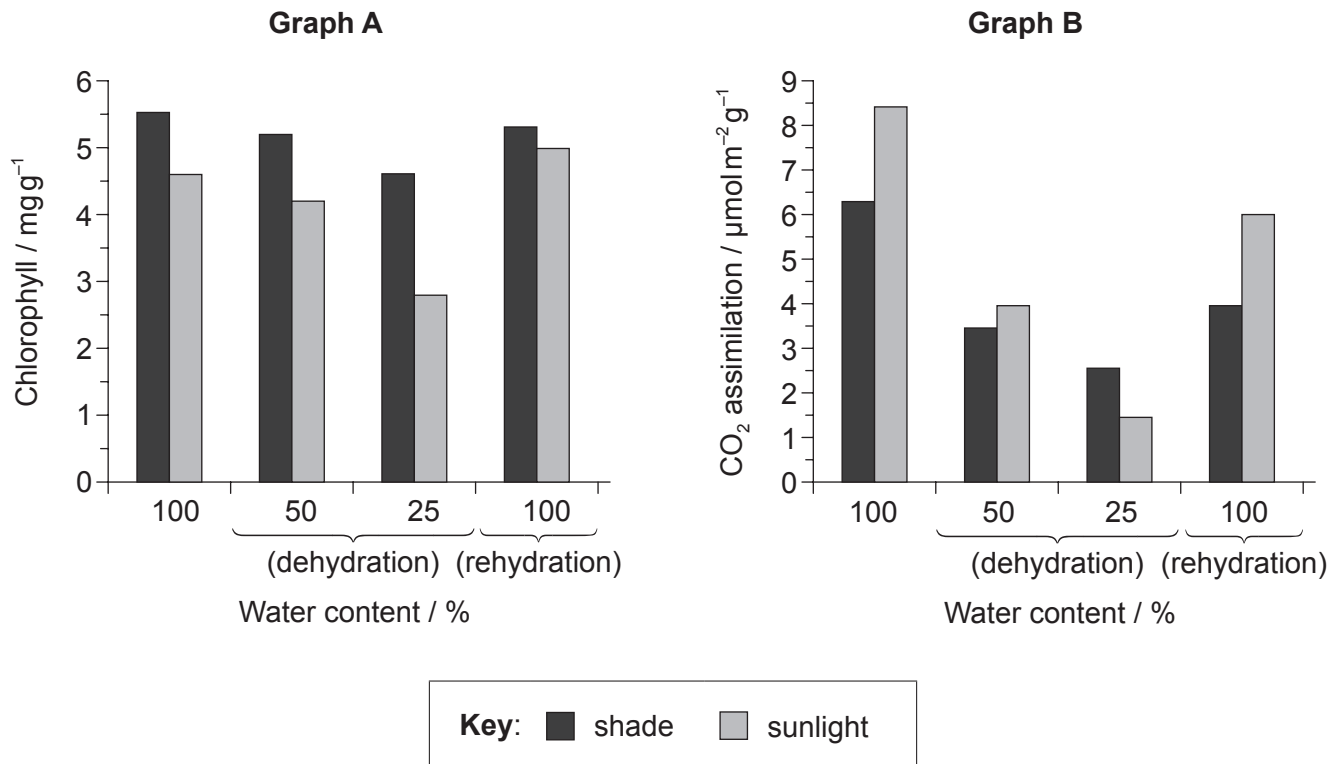
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End of Option B



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 continues on the following page)



(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]

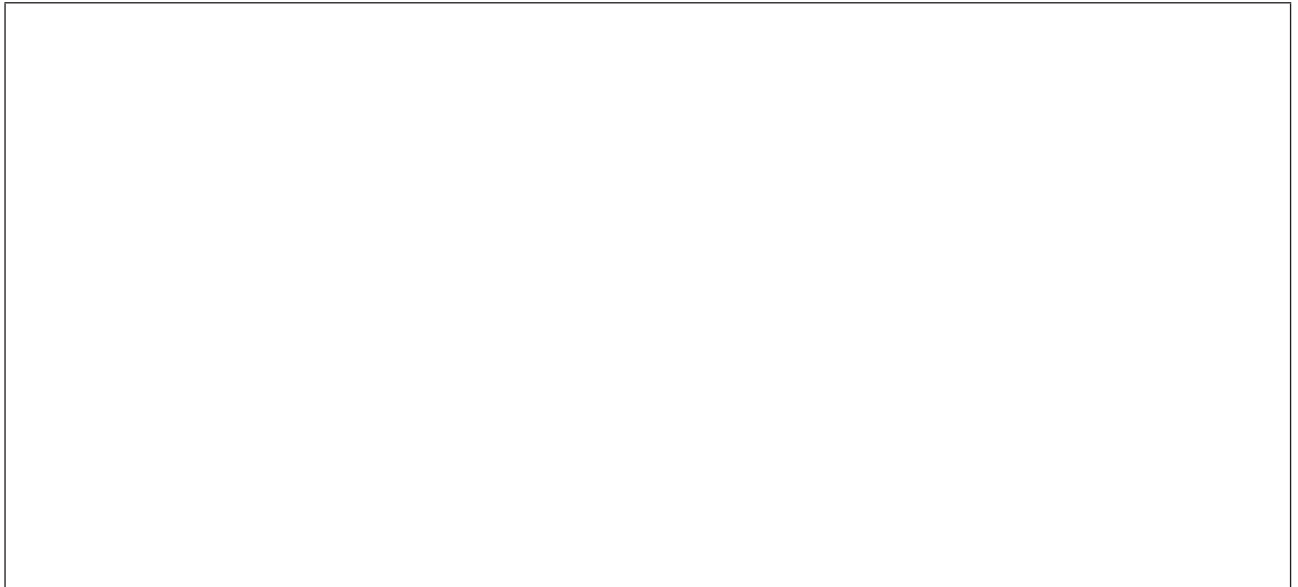
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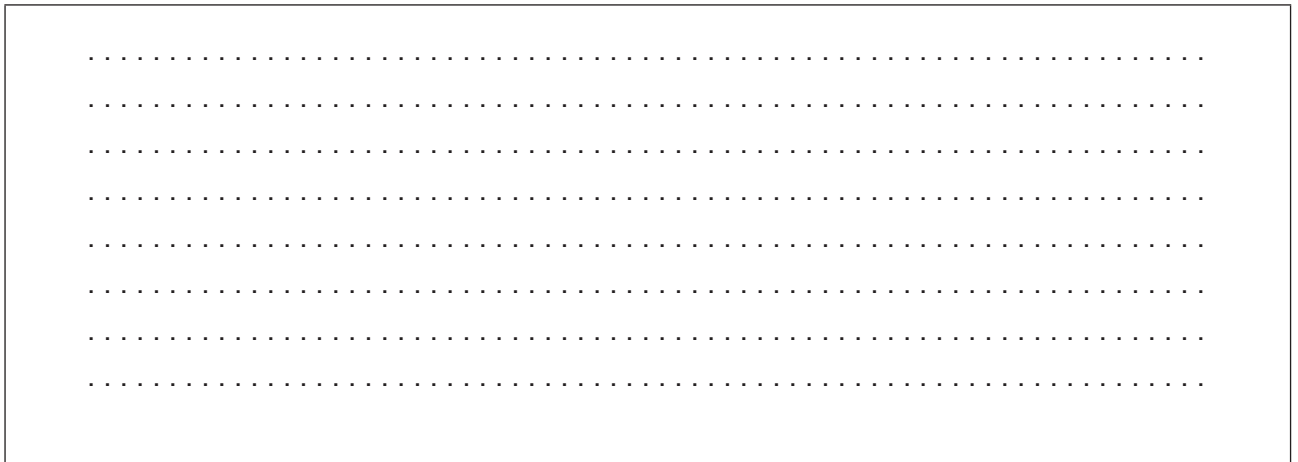


(Option C continued)

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]

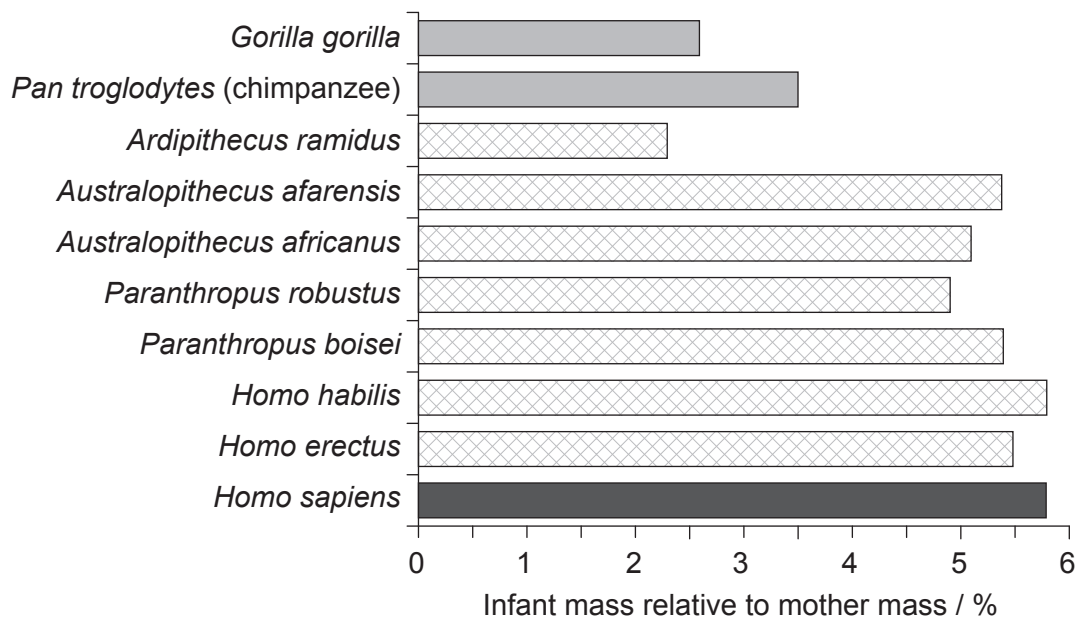
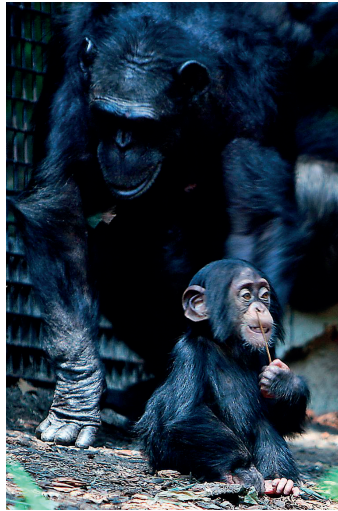


End of Option C



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)



32EP14

(Option D, question 10 continued)

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

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- (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]

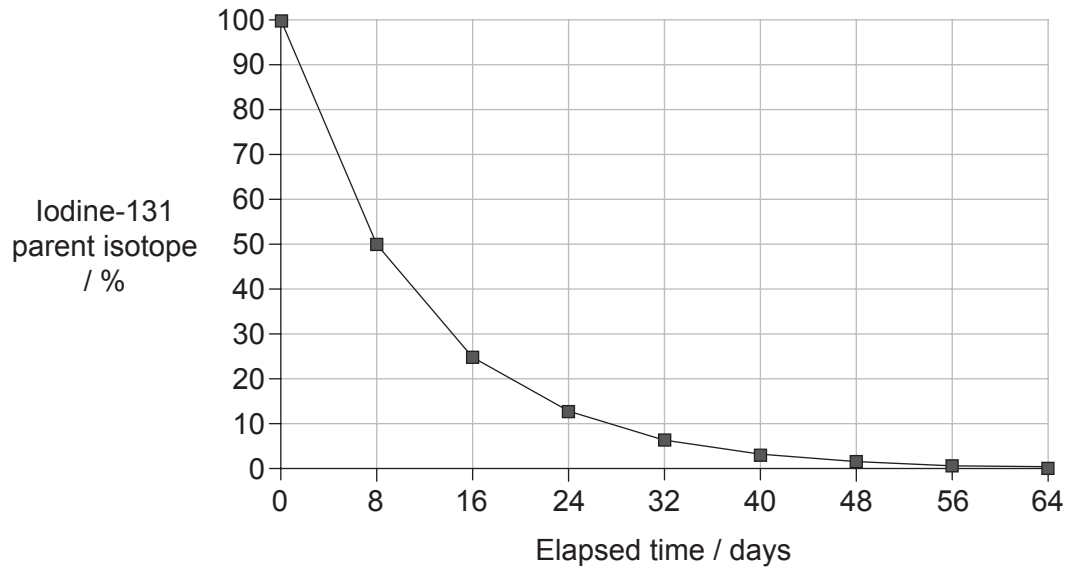
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(Option D continues on the following page)



(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)



32EP17

Turn over

(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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32EP19

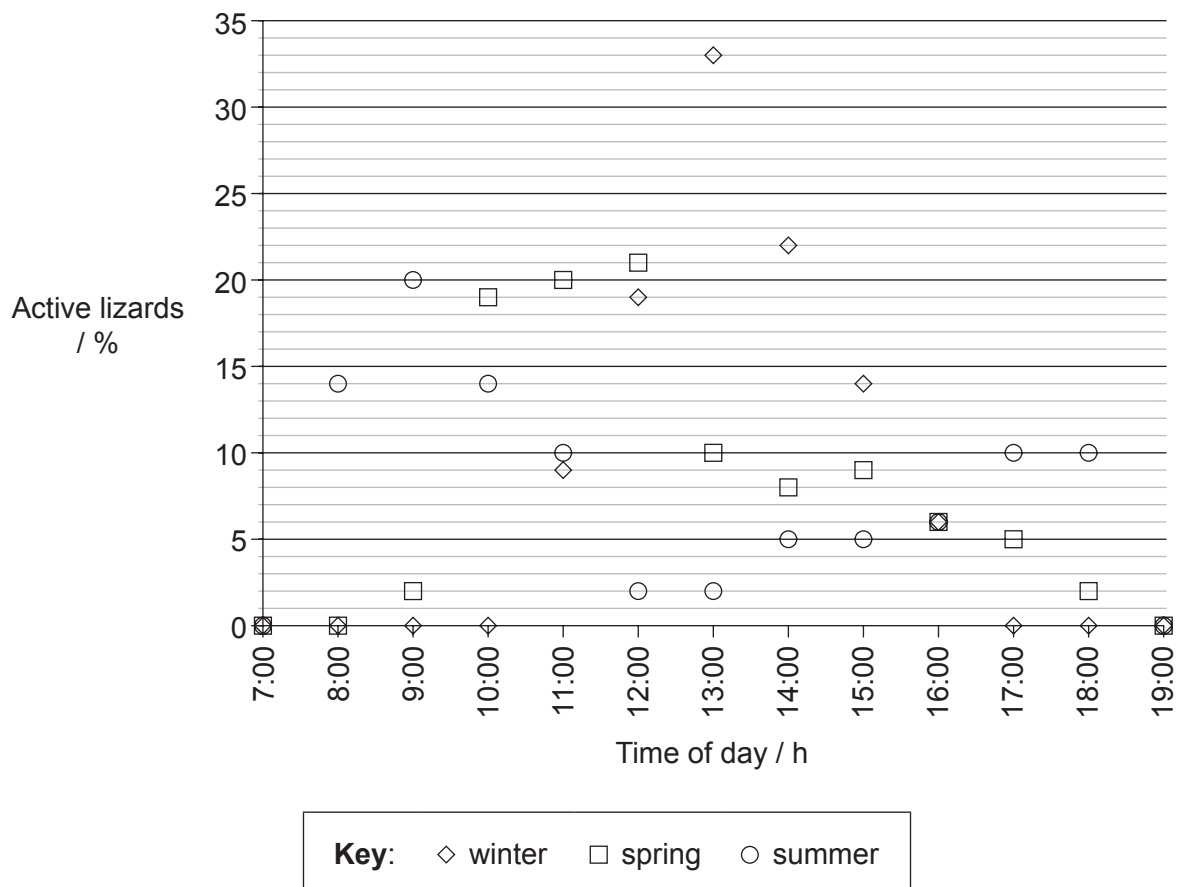
Turn over

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)



32EP20

(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)

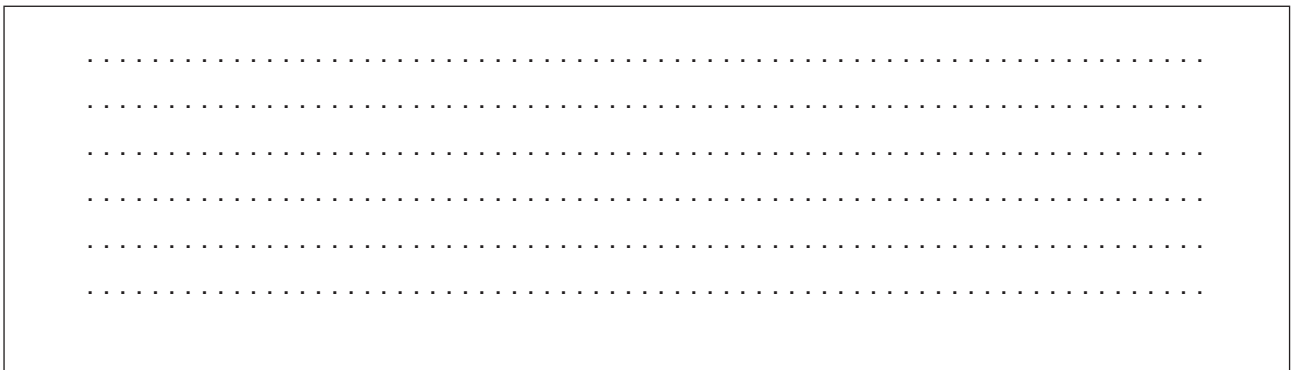


(Option E continued)

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)

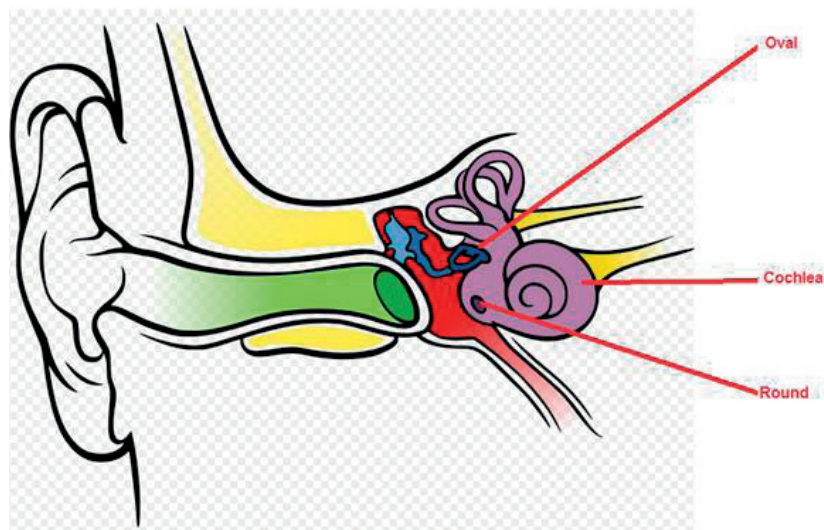
15. (a) Identify the type of retinal cells that function best in dim light. [1]

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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



32EP23

Turn over

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 continues on the following page)



32EP25

Turn over

(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]

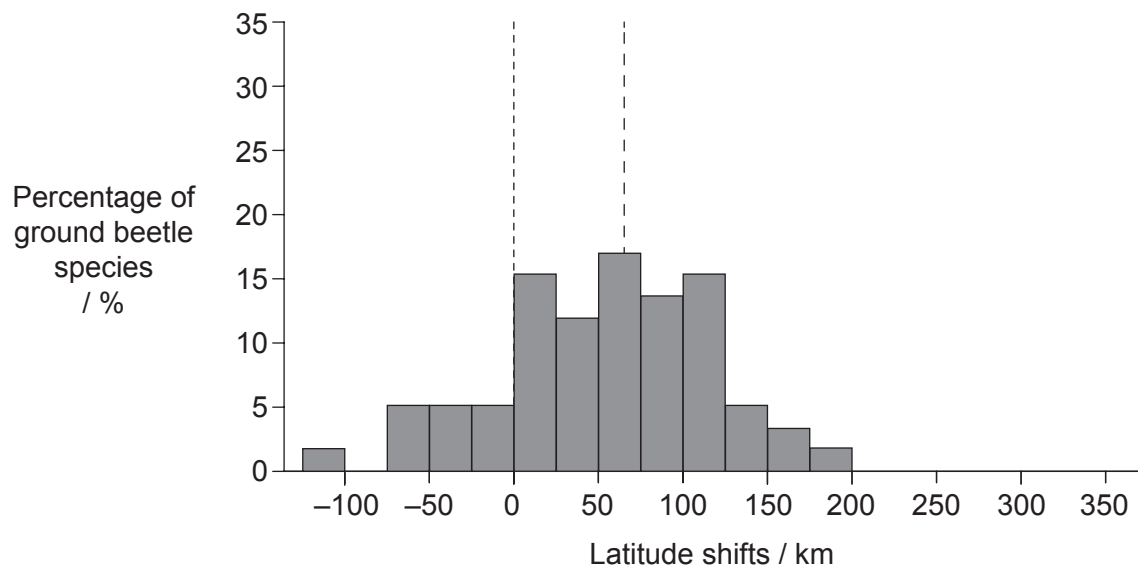
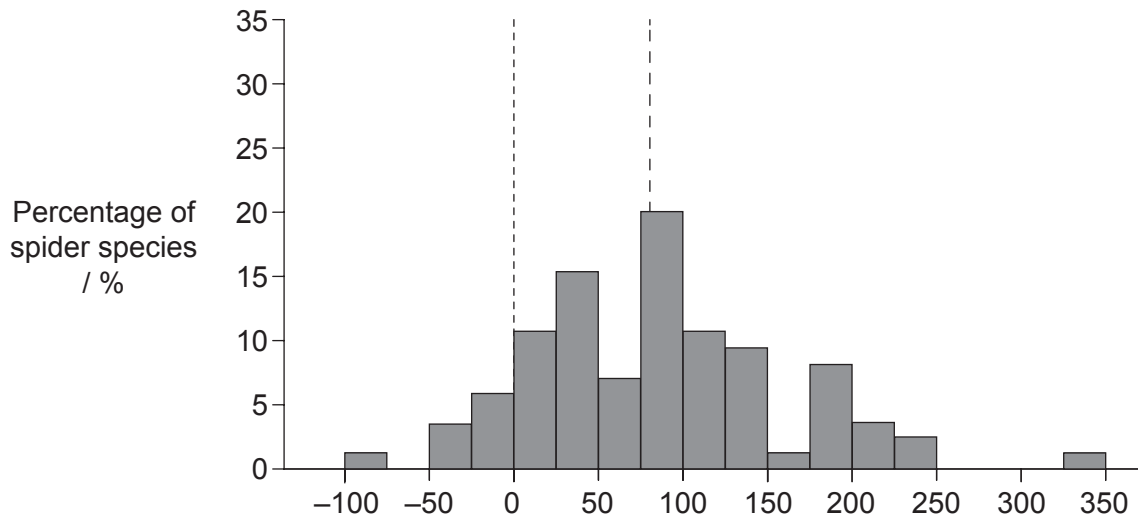
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End of Option F



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.

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(Option G continues on the following page)



32EP28

(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)



32EP29

Turn over

(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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32EP32