



**Biology**  
**Higher level**  
**Paper 3**

Friday 6 November 2015 (afternoon)

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.
- 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 **[40 marks]**.

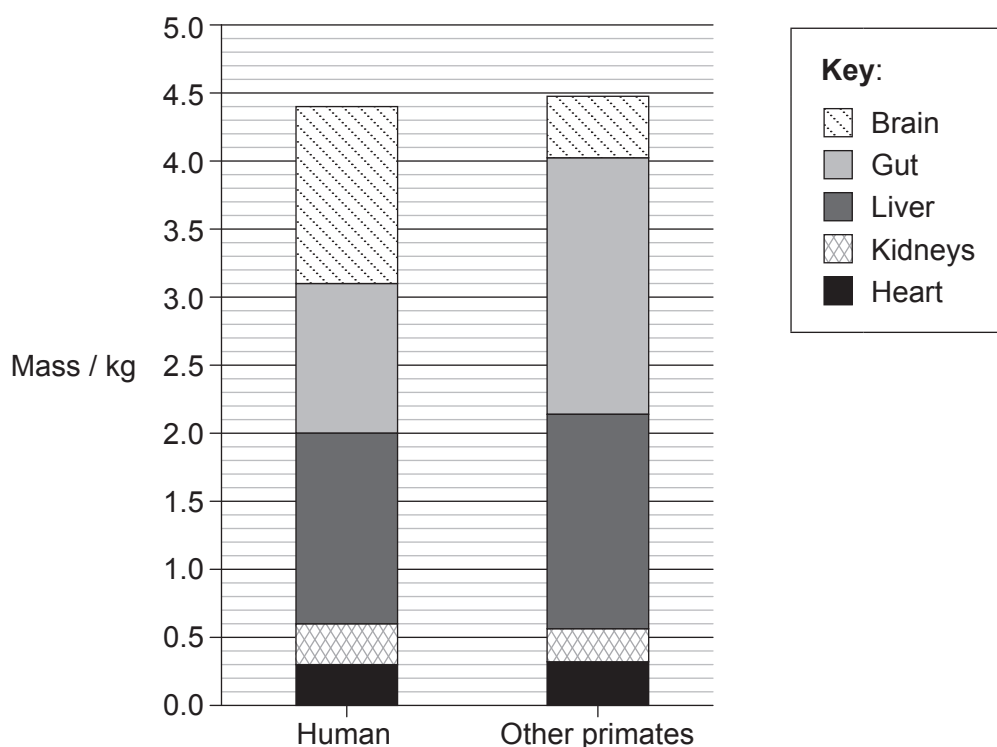
| Option                                | Questions |
|---------------------------------------|-----------|
| Option D — Evolution                  | 1 – 3     |
| Option E — Neurobiology and behaviour | 4 – 6     |
| Option F — Microbes and biotechnology | 7 – 9     |
| Option G — Ecology and conservation   | 10 – 12   |
| Option H — Further human physiology   | 13 – 15   |



**Option D — Evolution**

1. Researchers investigating human evolution recorded energy use for the brain, gastrointestinal tract (gut), liver, kidneys and heart as a percentage of total energy used in the human body. They found that these organs use around 70% of the body's energy although they account for only about 7% of body mass. They also compared the mass of each of these organs in humans with other modern primates, each with a body mass of 65 kg as shown in the bar chart.

| Human organs                                   | Brain | Gut | Liver | Kidneys | Heart |
|--|-------|-----|-------|---------|-------|
| Energy use as percentage of total for body / % | 16    | 15  | 19    | 8       | 11    |



[Source: Brains and guts in human evolution: The Expensive Tissue Hypothesis. *Braz. J. Genet.* [online]. 1997, vol.20, n.1 [cited 2015-11-17]. Available from: <[http://www.scielo.br/scielo.php?script=sci\\_arttext&pid=S0100-84551997000100023&lng=en&nrm=iso](http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-84551997000100023&lng=en&nrm=iso)>. ISSN 1678-4502. <http://dx.doi.org/10.1590/S0100-84551997000100023>.]

(Option D continues on the following page)



**(Option D, question 1 continued)**

- (a) Calculate the percentage of the total body mass made up by the human brain. [1]

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- (b) Compare the mass of human organs with the mass of other primate organs. [2]

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- (c) Using information from the table and the graph, identify the human organ which uses the greatest amount of energy per kilogram of body tissue. [1]

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- (d) Explain the differences between the organ size of humans and other primates in terms of trends in human evolution and their causes. [4]

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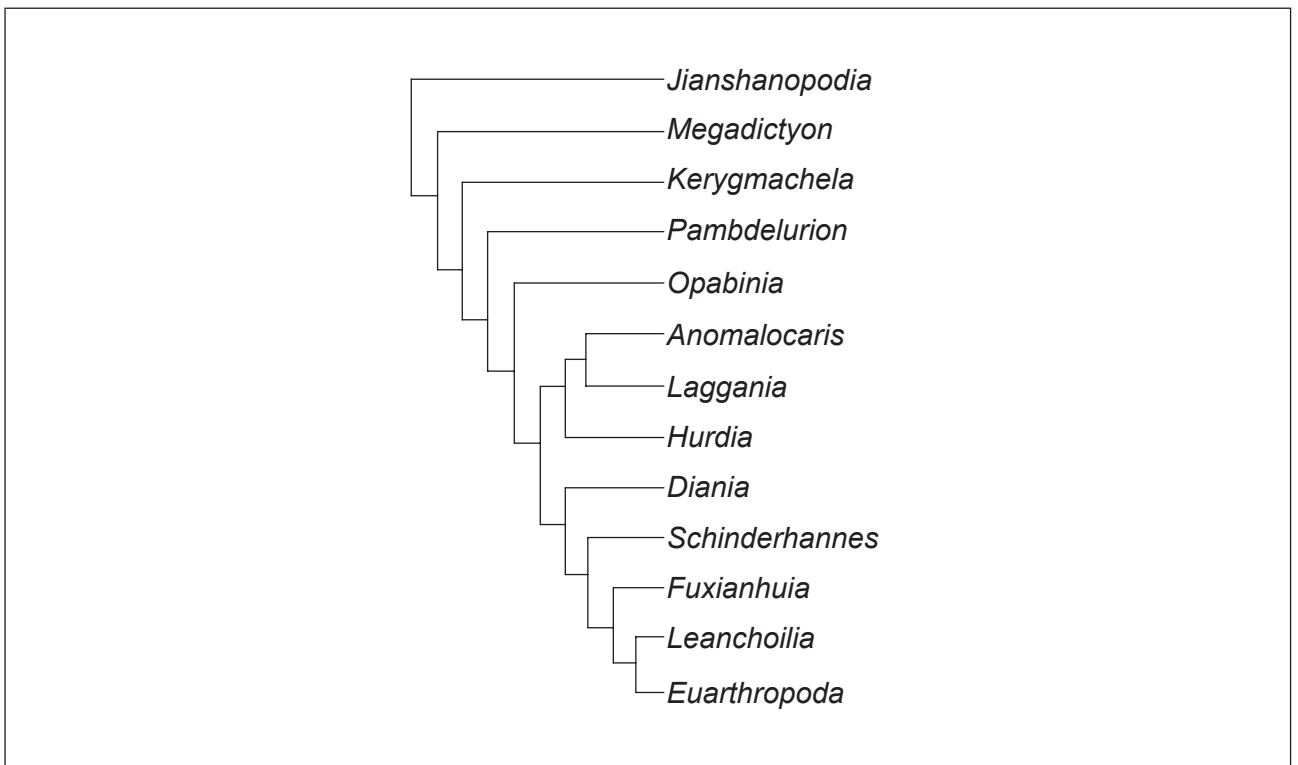


(Option D continued)

2. (a) Distinguish between allopatric speciation and sympatric speciation. [1]

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- (b) The diagram shows part of a cladogram for invertebrate species from the Cambrian age.



- (i) On the cladogram, label with the letter C the point that shows the most recent common ancestor of *Pambdelurion* and *Fuxianhuia*. [1]
- (ii) Identify which **two** species evolved most recently. [1]

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(Option D continues on the following page)



**(Option D, question 2 continued)**

- (c) 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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**(Option D continues on the following page)**



32EP05

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(Option D continued)

3. Discuss evolution by gradualism and punctuated equilibrium.

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**End of Option D**



32EP06

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32EP07

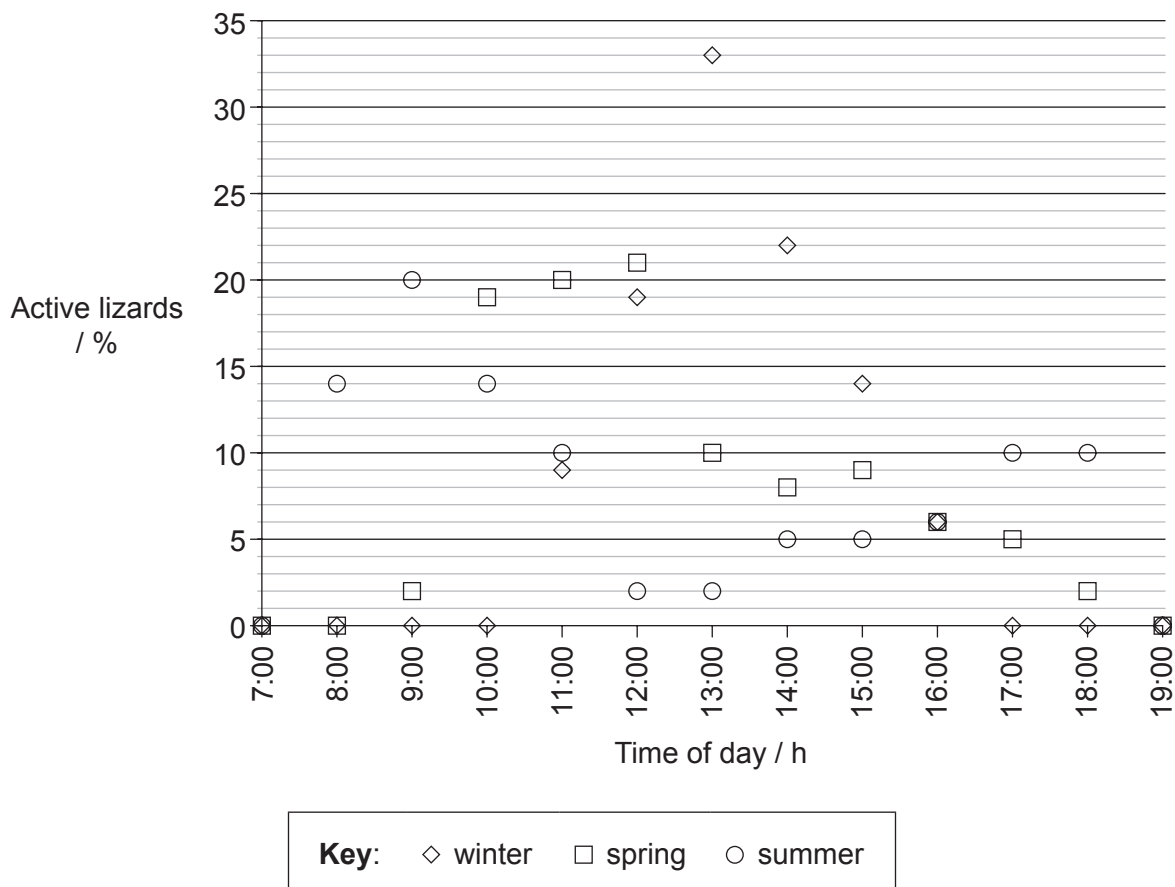
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### Option E — Neurobiology and behaviour

4. 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)



32EP08



(Option E, question 4 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) Outline **one** other example illustrating the adaptive value of a rhythmical behaviour pattern in a **named** animal. [3]

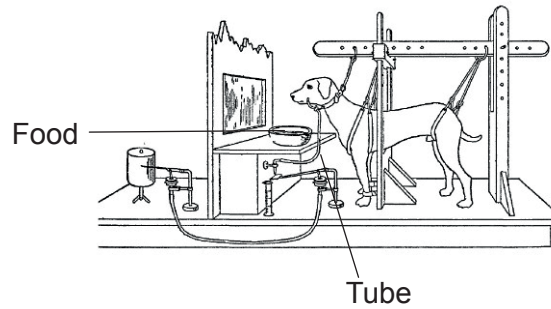
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(Option E continued)

5. (a) The diagram shows the procedure used by Pavlov during his experiment on dogs.



[Source: <http://www.all-about-psychology.com/images/pavlovs-dog.jpg>]

(i) State the type of stimulus provided by the sight and smell of the food. [1]

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(ii) State the function of the tube. [1]

.....

(b) State **two** effects presynaptic neurons could have on postsynaptic transmission. [1]

1. ....  
2. ....

(Option E continues on the following page)



**(Option E, question 5 continued)**

- (c) Describe **one** experiment that could be used to investigate taxis behaviour in a **named** invertebrate.

[3]

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**(Option E continues on the following page)**



32EP11

Turn over

**(Option E continued)**

**6.** Explain how the ear converts sound waves in the air to the nerve impulses sent to the brain. [6]

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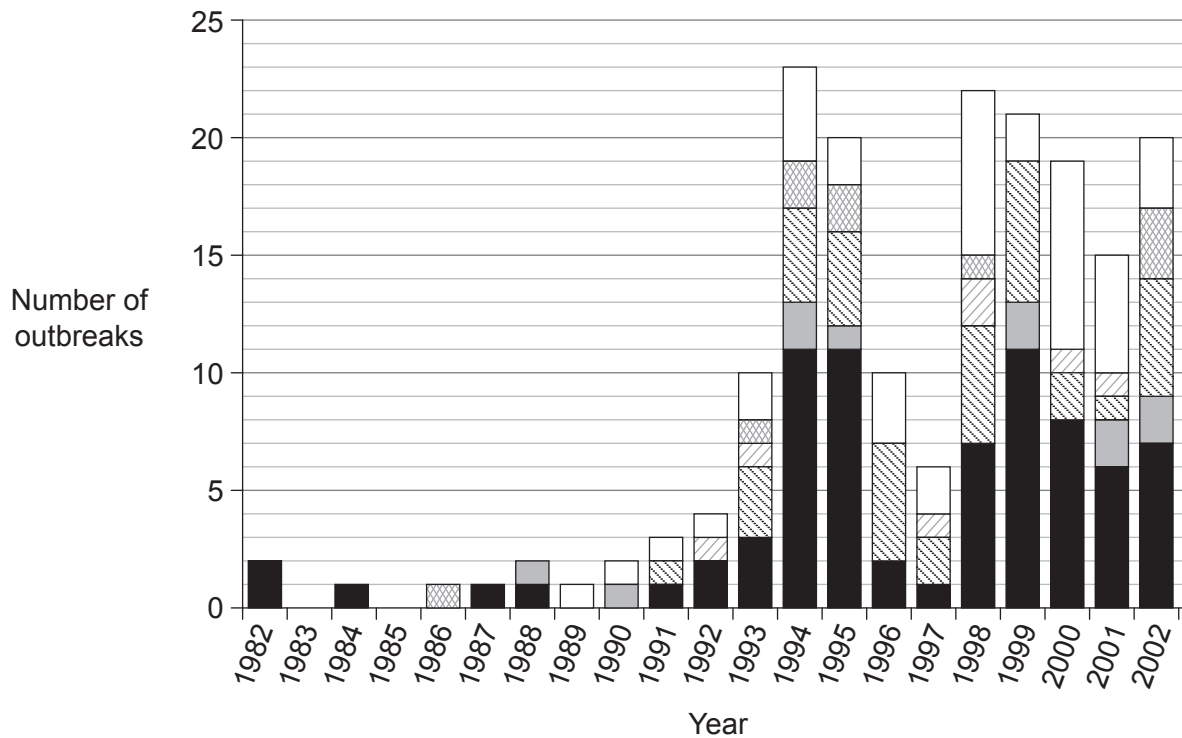


32EP13







Turn over

### Option F — Microbes and biotechnology

7. The bacterium *Escherichia coli* is responsible for over 70 000 cases of illness each year in the US. More than half of these cases are due to transmission of the bacteria in food, particularly from ground beef in undercooked burgers. Epidemiologists collected evidence from 183 outbreaks of food poisoning between the years 1982 and 2002 and identified the food responsible for the outbreak. They divided the foods into dairy products, fruit and vegetables, beef, ground beef (beef which has been minced) and other foods. In some cases they were unable to identify the food that had caused the outbreak. The results are displayed in the bar chart.



#### Key:

-  unknown food source
-  other foods
-  dairy products
-  fruit and vegetables
-  beef (not ground)
-  ground beef

[Source: Rangel JM, Sparling PH, Crowe C, Griffin PM, Swerdlow DL.

Epidemiology of *Escherichia coli* O157:H7 outbreaks, United States, 1982–2002. *Emerg Infect Dis* [serial on the Internet]. 2004 Apr. Available from <http://wwwnc.cdc.gov/eid/article/11/4/04-0739> DOI: 10.3201/eid1104.040739]

(Option F continues on the following page)



32EP14

(Option F, question 7 continued)

- (a) State the number of years during the study when contaminated dairy products caused food poisoning. [1]

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- (b) (i) Compare the outbreaks of food poisoning in 1989 and 1994. [2]

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- (ii) Suggest **two** reasons for these changes. [2]

1. ....  
2. ....

- (c) Explain how pasteurization may have prevented food poisoning by dairy products. [2]

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(Option F continues on the following page)



(Option F continued)

8. (a) State **one** example of a bacterium that forms aggregates. [1]

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(b) State the type of bacteria that are adapted to a habitat with high salt concentrations. [1]

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(c) 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, question 8 continued)

(d) The image shows part of a sewage treatment plant.



[Source: "Trickling filter bed 2 w" by Velela - Transferred from en.wikipedia.org [1]: 2005-01-16 21:23 Velela 1296x972 (680941 bytes). Licensed under Public Domain via Wikimedia Commons - [https://commons.wikimedia.org/wiki/File:Trickling\\_filter\\_bed\\_2\\_w.JPG#/media/File:Trickling\\_filter\\_bed\\_2\\_w.JPG](https://commons.wikimedia.org/wiki/File:Trickling_filter_bed_2_w.JPG#/media/File:Trickling_filter_bed_2_w.JPG)]

Outline the role of bacteria in trickling filter bed treatment of sewage.

[3]

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(Option F continues on the following page)



32EP17

Turn over



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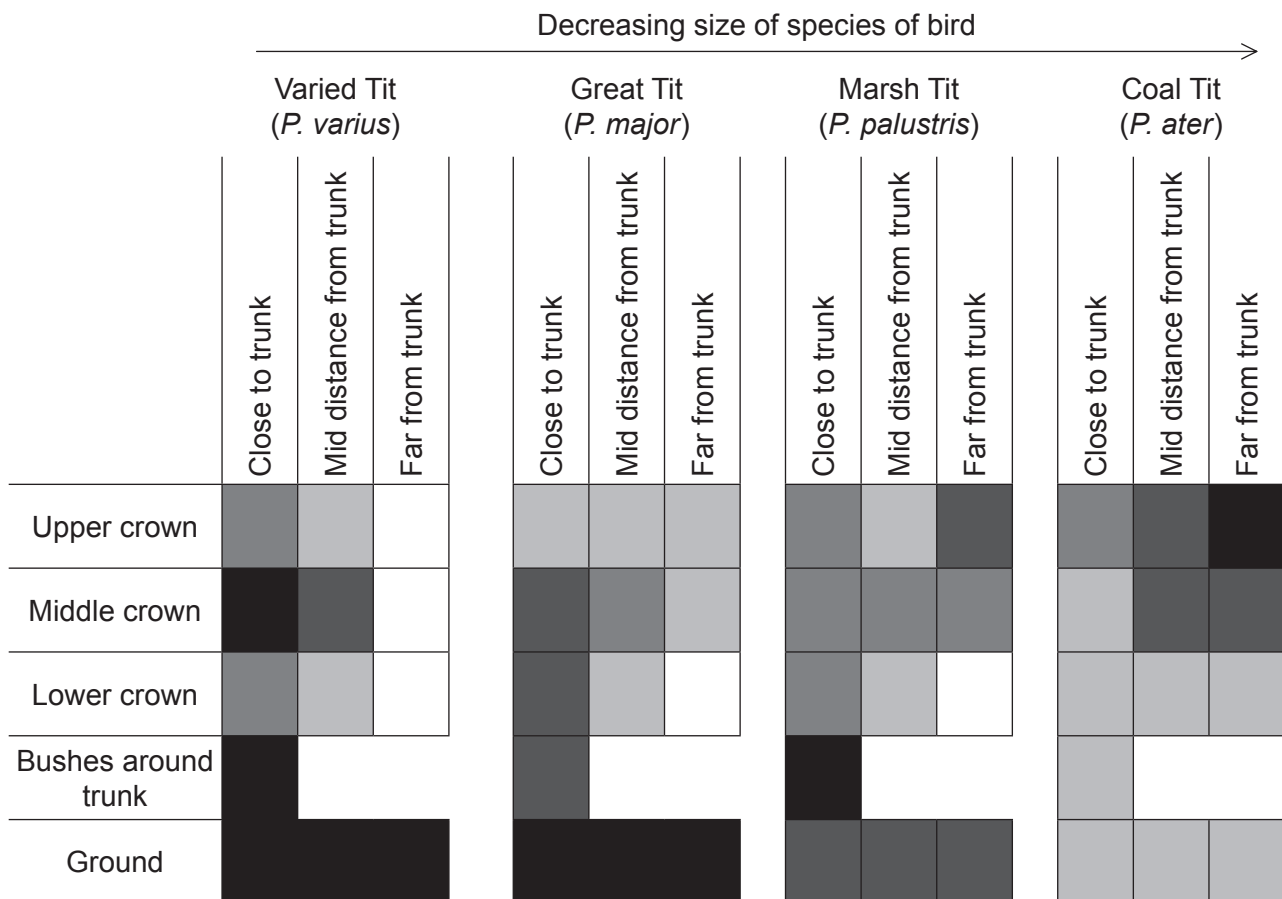


32EP19

Turn over

### Option G — Ecology and conservation

10. In South Korea, flocks of birds of the tit family (*Paridae*) forage together on trees for food. Researchers observed four species of *Paridae* to determine whether they shared the same habitat in the trees and whether their position on the tree depended on their size. The leafy part of the tree (crown) was divided into nine sections, three according to height from the ground and three according to the distance from the tree trunk. Observations were also made of birds foraging in the bushes surrounding the trunk and on the ground below the tree. The chart shows the relative use of each section of the habitat by the birds.



**Key:** relative use

high
  medium to high
  medium
  medium to low
  low

[Source: S. Lee and P. G. Jablonski (2006) *Polish Journal of Ecology*, **54** (3), pages 481–490.]

(Option G continues on the following page)



**(Option G, question 10 continued)**

- (a) State the relative use of the habitat by the Great Tit in the upper crown of the tree close to the trunk. [1]

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- (b) Identify the section of habitat used least by the birds. [1]

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- (c) Compare how the Varied Tit and the Marsh Tit use the habitat in the upper crown of the tree. [2]

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- (d) State how the distribution of birds changes with their size in the middle crown of the tree. [1]

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- (e) Suggest **one** reason why few Varied Tits were found far from trunk. [1]

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**(Option G continues on the following page)**



(Option G, question 10 continued)

(f) Discuss whether the results for the Varied Tit and Coal Tit indicate competitive exclusion. [2]

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(Option G continues on the following page)



**(Option G continued)**

11. (a) (i) State which environmental conditions would favour r-strategies of reproduction over K-strategies. [1]

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- (ii) Outline **one** advantage to a species of using r-strategy. [1]

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- (b) Outline how habitat corridors can aid conservation of biodiversity in a nature reserve. [1]

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

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**(Option G continues on the following page)**



(Option G continued)

12. Discuss, using **three** examples, how alien species have impacted ecosystems.

[6]

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**End of Option G**





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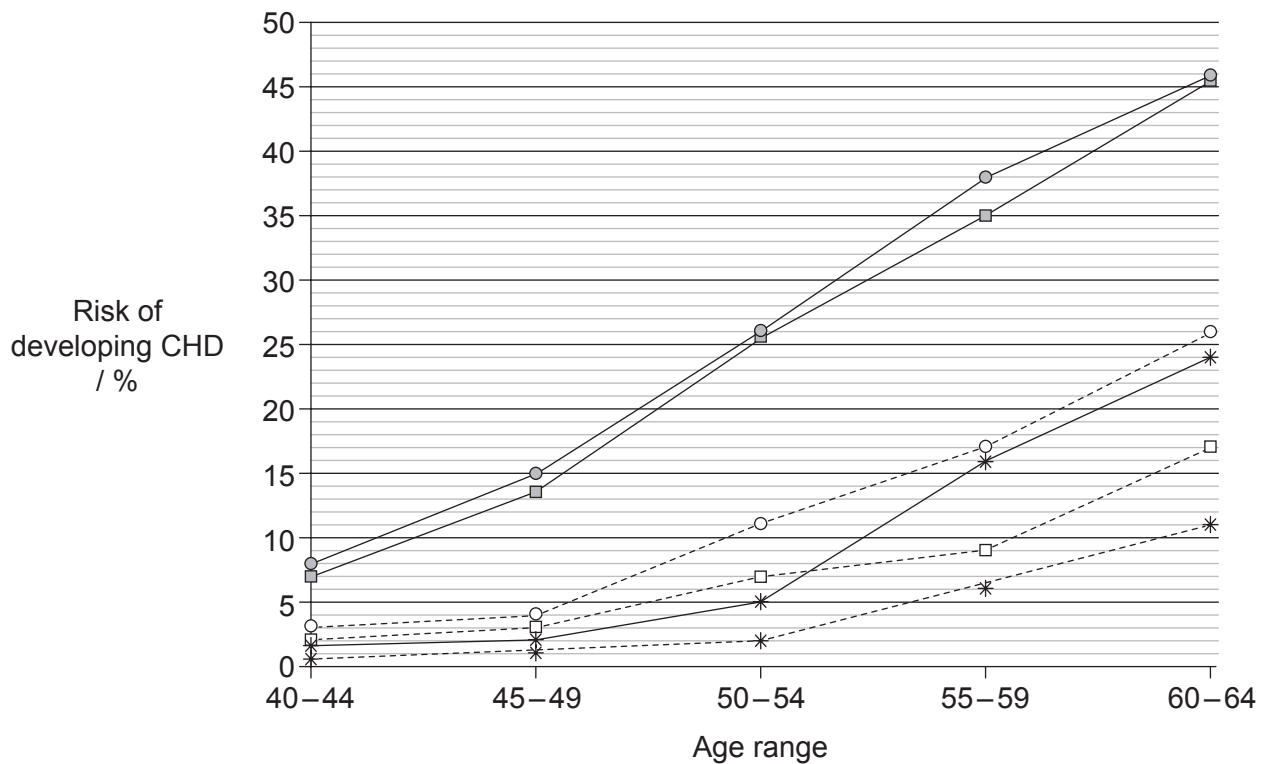


32EP25

Turn over

### Option H — Further human physiology

13. Coronary heart disease (CHD) is common in some families, with men being more susceptible to the disease than women. Researchers in Finland carried out an investigation to determine whether the pattern within families was the same for women as for men. The graph shows how the risk of developing CHD in men and women of certain ages depends on whether they had a brother or sister with the disease.



**Key:** —□— men whose brothers had CHD      - -□- - women whose brothers had CHD  
 —○— men whose sisters had CHD      - -○- - women whose sisters had CHD  
 —\*— male control      - -\* - female control

[Source: Pohjola-Sintonen S. *et al.* Family history as a risk factor of coronary heart disease in patients under 60 years of age. *European Heart Journal* Feb 1998, **19** (2), 235–239; DOI: 10.1053/euhj.1997.0543, Figs 1 & 2. © 1998, by permission of Oxford University Press.]

- (a) State the risk of a man developing CHD between the ages of 55–59 if his brother had CHD. [1]

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(Option H continues on the following page)



(Option H, question 13 continued)

- (b) Calculate the increase in risk over the control group for a woman of 60–64 of developing CHD if her sister had the disease. [1]

.....%

- (c) Compare the results for the men and the women. [3]

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- (d) Suggest **two** reasons why a man is more likely to develop CHD if his brother had the disease. [2]

1. ....  
2. ....

(Option H continues on the following page)



**(Option H continued)**

14. (a) State the pathway by which hormones travel from the hypothalamus to the anterior pituitary gland. [1]

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- (b) State the condition of the blood that would stimulate the release of ADH (vasopressin). [1]

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- (c) Outline the function of gastrin. [2]

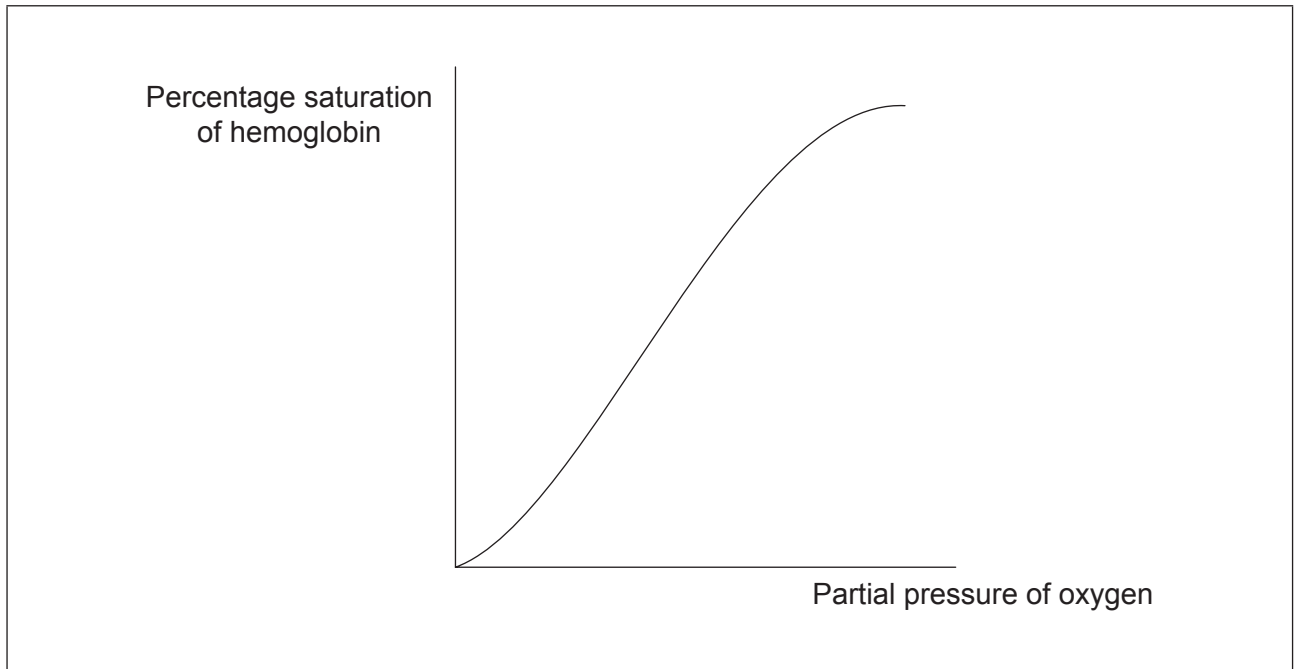
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**(Option H continues on the following page)**



(Option H, question 14 continued)

(d) The graph shows the oxygen dissociation curve for adult hemoglobin.



- (i) Using the graph, draw a line to show how the oxygen dissociation curve changes with the Bohr shift. [1]
- (ii) Explain the role of the Bohr shift during vigorous exercise. [2]

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(Option H continues on the following page)



(Option H continued)

15. Explain the role of the liver in regulating and storing nutrients.

[6]

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**End of Option H**



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32EP32