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BIOLOGY
STANDARD LEVEL
PAPER 3

Tuesday 14 May 2013 (morning)

1 hour

Candidate session number

0	0								

Examination code

| 2	2	1	3	–	6	0	1	8

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 A — Human nutrition and health

A1. Malnutrition affects the body mass index (BMI) of mothers. The height and mass of over 7000 mothers in Ethiopia and the sex of their most recently born child was recorded. The graph shows the percentage of mothers with a BMI below 18.5 and the percentage of their most recent births that were males in 11 regions across Ethiopia.
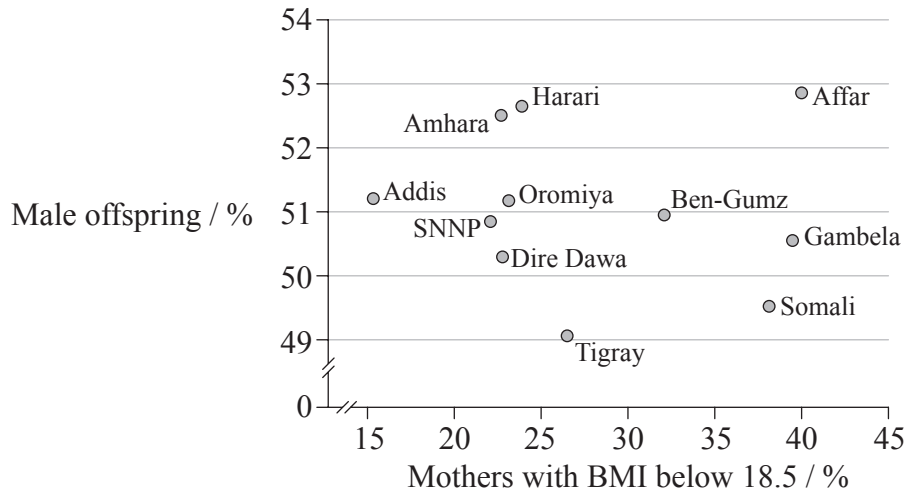
[Source: Aryeh D. Stein, Paul G. Barnett, Daniel W. Sellen, Maternal undernutrition and the sex ratio at birth in Ethiopia: evidence from a national sample, *Proc. R. Soc. Lond. B* (Suppl.), 271, 2004, pages S37–S39, by permission of the Royal Society.]

(a) State the regions with the highest and lowest percentage of male offspring. *[1]*

Region with highest percentage:

....

Region with lowest percentage:

....

(This question continues on the following page)

(Question A1 continued)

(b)   Comment on the variation in BMI of mothers in Ethiopia.   *[2]*

(c)   Discuss whether the data supports the hypothesis that malnutrition affects the sex ratio
      of offspring.   *[2]*

(d)   Suggest **one** limitation of the data.   *[1]*

(e)   Suggest **one** factor that could cause malnutrition in mothers.   *[1]*

Turn over

A2. (a) (i) Define *nutrient*. *[1]*

(ii) Distinguish between essential and non-essential amino acids. *[1]*

(b) Explain the benefits of supplementing a diet with iodine. *[2]*

(c) Evaluate the health consequences of a diet rich in polyunsaturated fatty acids. *[2]*

A3. (a) Rice is the staple diet for many Chinese, whereas fish is the staple diet for Inuits. Compare these foods as a source of energy. *[2]*

(b) List **two** reasons for increases in the rate of clinical obesity. *[2]*

1. ....

2. ....

(c) State **one** advantage of breast milk for an infant. *[1]*

Turn over

Option B — Physiology of exercise

B1. An investigation was conducted among competitive swimmers to determine the effects of two different training programmes.

3000 m programme: 6×500 m front crawl swims with 1-minute rests between each swim

6000 m programme: 60×100 m front crawl swims with 20-second rests between each swim

Swimmers were encouraged to maintain an even pace throughout the programmes. The pace was slightly slower in the 3000 m programme than in the 6000 m programme.

Tissue samples were taken from the shoulder muscle of each swimmer, before and after each session. Glycogen levels were analysed in slow (type I) muscle fibres.
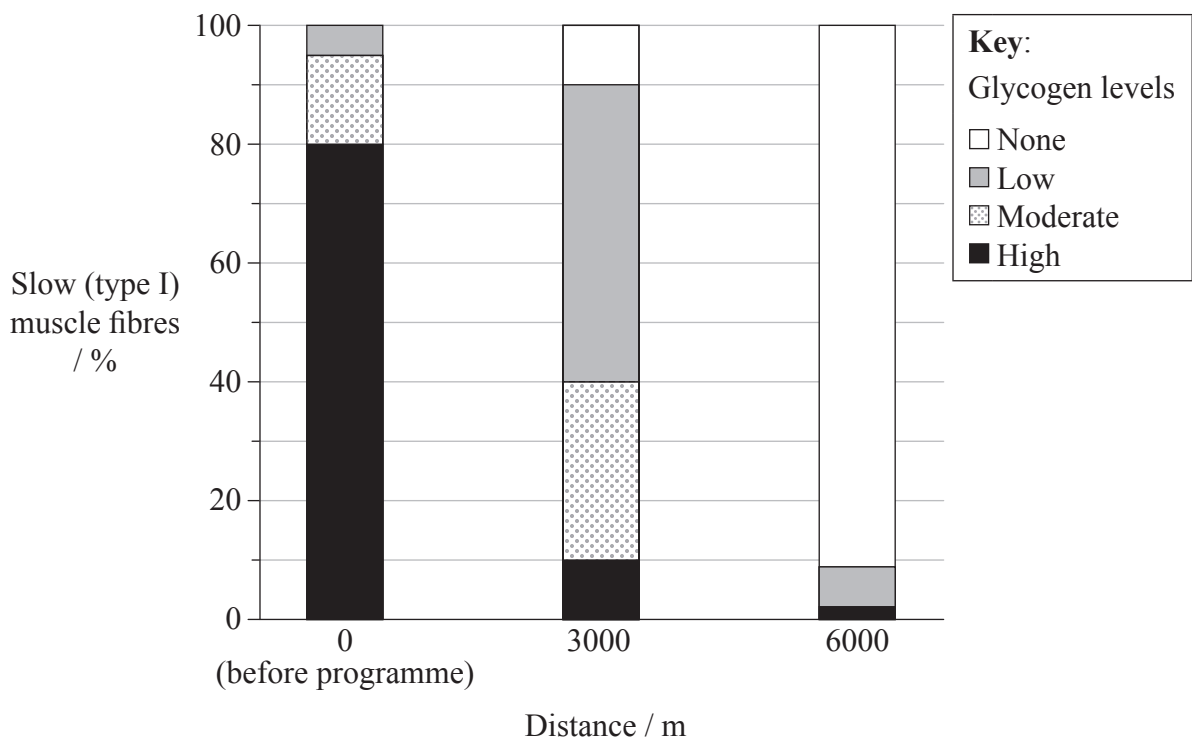
[Source: adapted from D H Costill, *et al.*, (1988), *Journal of Swimming Research*, **4**(1), pages 13–18.
Used with the author's permission.]

(a) Calculate the percentage of slow (type I) muscle fibres that contain low levels of glycogen after the 3000 m programme. *[1]*

. . . . %

(This question continues on the following page)

(Question B1 continued)

(b)   State the effect of the 3000 m programme on glycogen levels in slow (type I) muscle
       fibres.   *[1]*

       ....

(c)   (i)   Compare the effects of the 3000 m programme with the 6000 m programme on
              muscle glycogen levels.   *[2]*

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

       (ii)   Suggest reasons for the differences between the 3000 m programme and the
              6000 m programme in their effects on muscle glycogen levels.   *[2]*

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

(d)   Suggest **one** limitation of the data.   *[1]*

       ....
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Turn over

B2. (a) Analyse the electron micrograph for the state of contraction of the muscle fibre. *[2]*

Z line   Z line

[Source: http://click4biology.info/c4b/11/hum11.2.htm
Used with permission.]

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(b) Outline ATP production in muscle fibres during intense exercise. *[2]*

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(c) Explain the role of ATP in muscle contraction. *[2]*

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B3. (a)   List **two** structural features of a joint that reduce friction between bones.   *[2]*

1.   . . . .

2.   . . . .

(b)   Distinguish between stroke volume and cardiac output.   *[1]*

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(c)   (i)   State which part of the body receives the same rate of blood flow during exercise and at rest.   *[1]*

. . . .

(ii)   State **one** reason for deep rapid ventilations after vigorous exercise.   *[1]*

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Option C — Cells and energy

C1. As green bananas ripen, chlorophyll is broken down into various products called catabolites. In some varieties of banana, catabolites fluoresce (glow blue under UV light). This fluorescence appears as rings surrounding the dark spots on banana skin. Dark spots are the ripest areas. The graph shows the intensity of emission of light by fluorescence from three regions on a ripening banana's skin as shown on the inset image.
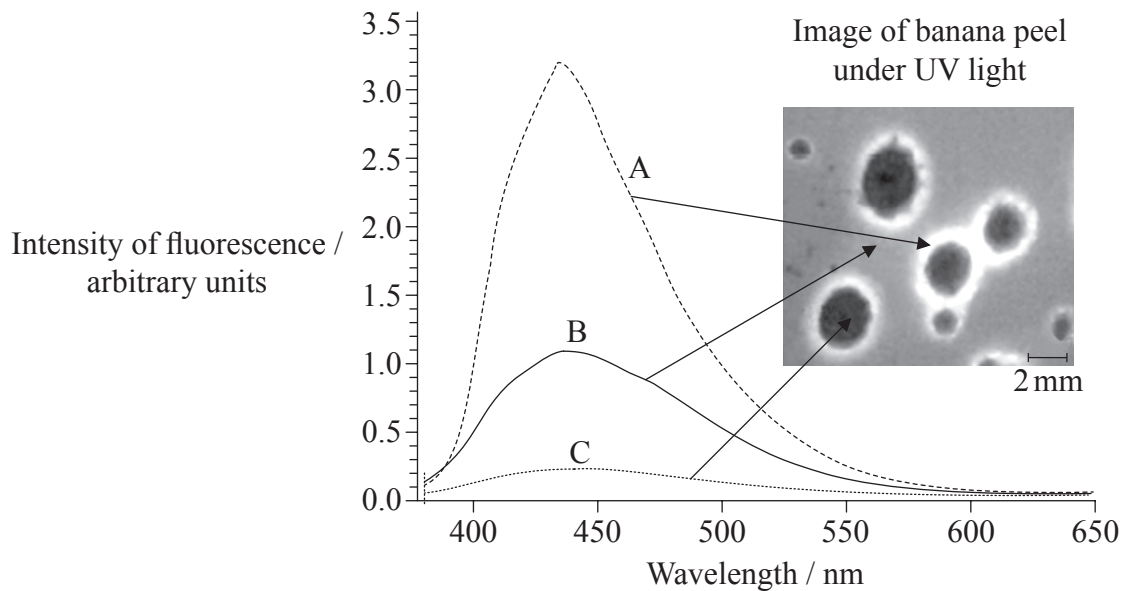
[Source: Simone Moser et al. (2009), "Fluorescent chlorophyll catabolites in bananas light up blue halos of cell death", *PNAS* 106 (37), 15, 538–15, 543.]

(a) Identify the maximum intensity of fluorescence for the catabolites in the fluorescent rings. *[1]*

....
....

(b) Compare the emissions by fluorescence in UV light of regions A, B and C. *[2]*

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

(This question continues on the following page)

(Question C1 continued)

(c) The region of banana skin labelled B on the image is yellow in colour. Deduce the changes in the amount of fluorescence that will occur as the yellow regions ripen until they are black. *[1]*

(d) Suggest how fluorescence could be used commercially in the banana production industry. *[1]*

Turn over

C2. (a)   Transport is the function of the protein known as hemoglobin. State the name and function
of another protein. Do not use enzymes or membrane proteins for your answer.   *[1]*

Name: . . . .

Function: . . . .

(b)   Explain the role of enzymes in metabolic pathways.   *[4]*

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(c)   Describe how the link reaction and the Krebs cycle are related.   *[2]*

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. . . .

C3. (a)   Distinguish between oxidation and reduction in biological reactions.   *[2]*

Oxidation	Reduction

(b)   State **two** products of glycolysis.   *[1]*

1. . . . .

2. . . . .

(c)   Explain the role of cristae in mitochondria.   *[3]*

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Turn over

**Option D — Evolution**

D1. Bone tools found in the Swartkrans site in South Africa were thought to be used by *Australopithecus robustus* when digging for food. Using replica tools, researchers dug around plants for bulbs, dug in soil for larvae and dug in termite mounds for termites. They compared the scratch marks found on the replica tools with those on the original Swartkrans tool to predict the food eaten by *A. robustus*.

Original tool	**Replica tools**		
Swartkrans	**Plant bulbs**	**Larvae**	**Termites**
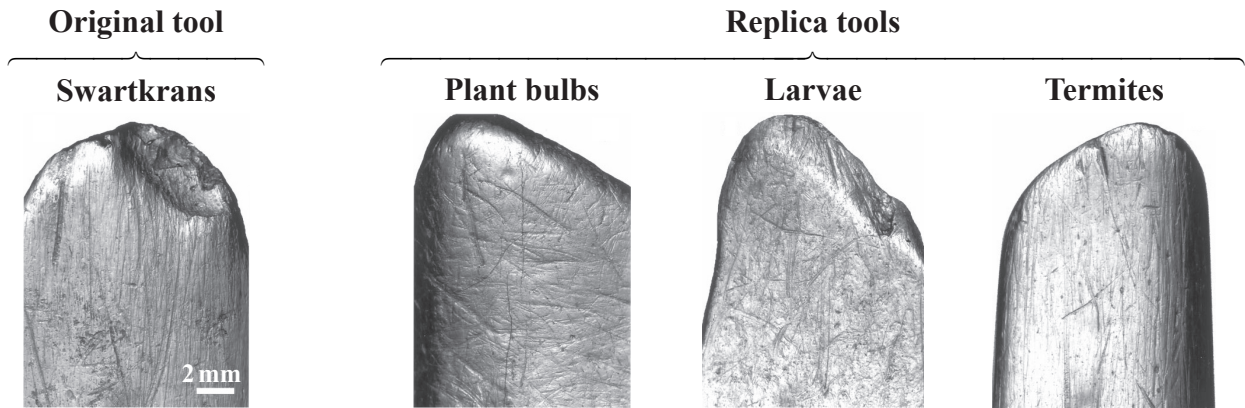
The graphs below show the ranges of angles from the vertical position of the scratch marks and the ranges of widths of the scratch marks on each tool. The solid line on each bar represents the average value for the range.
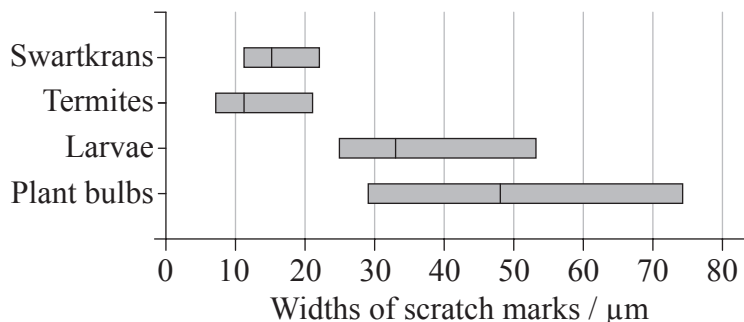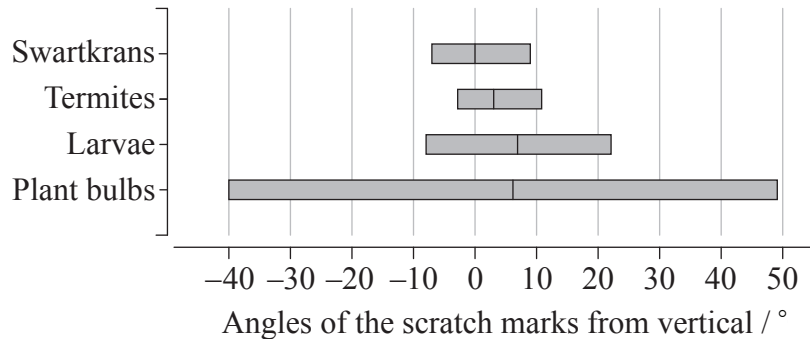
Angles of the scratch marks from vertical / °

Widths of scratch marks / μm

(This question continues on the following page)

(Question D1 continued)

(a)   State the greatest angle from the vertical of the scratch marks on the tool used on termite mounds. *[1]*

....

(b)   Calculate the difference in the angle between the average values for the Swartkrans tool and the tool used to dig for plant bulbs. *[1]*

....

(c)   Compare the width of scratch marks on the tool used to dig for larvae with the Swartkrans tool. *[2]*

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

(d)   Using evidence from the photographs and the graphs, suggest what the researchers' main conclusion was. *[2]*

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

(This question continues on the following page)

(Question D1 continued)

(e)   *A. robustus* was thought to have coexisted with *Homo habilis*, both becoming extinct at
      the same time. State approximately how many years ago *A. robustus* became extinct.   *[1]*

....

D2.   (a)   State a radioisotope that could be used to date fossils.   *[1]*

....

(b)   List **two** anatomical features of humans that are characteristic of primates.   *[2]*

1.   ....

2.   ....

(c)   Outline the possible influence of a change in diet on hominid evolution.   *[2]*

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

D3. (a) State the aim of the experiments by Miller and Urey. *[1]*

(b) Explain how the presence of RNA in some protobionts may have benefited them. *[2]*

(c) Discuss the definition of the term species. *[3]*

Turn over

Option E — Neurobiology and behaviour

E1. The hypothesis that aging involves loss of brain cells was investigated in mice. The olfactory bulb (OB) of the brain was studied because its layered arrangement of neurons resembles large regions of the human brain. Sensory input about smell is sent to the OB by axons of receptor cells that line the upper nasal cavity. These axons synapse with relay neurons in the OB where interpretation of smell perception begins. The bar charts show the total volume of neurons in the OB and the density of synapses (number of synapses per unit area) in two regions of a mouse's OB.
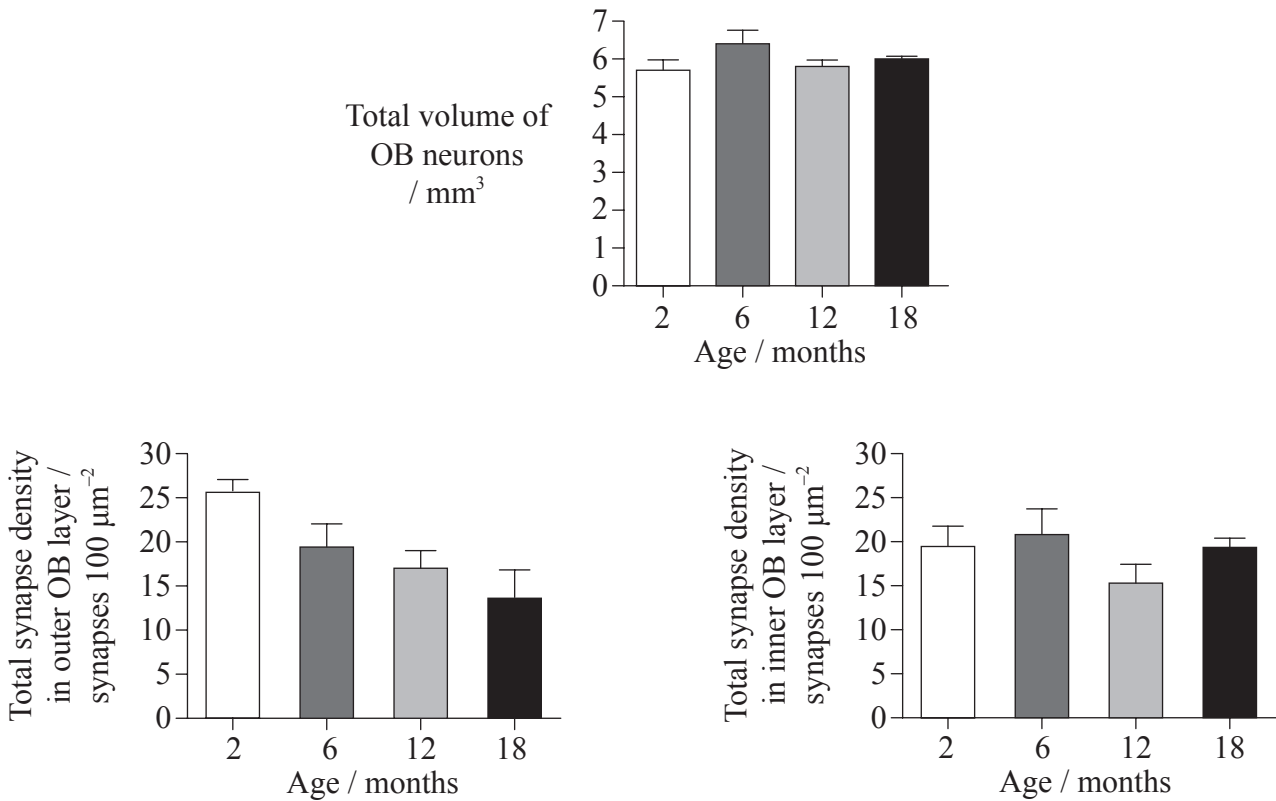
(a)   State when the total volume of OB neurons is the greatest.   *[1]*

....

(This question continues on the following page)

(Question E1 continued)

(b)   Compare the total synapse density of neurons in the outer and inner OB layers.   *[2]*

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. . . .

. . . .

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(c)   Evaluate, using the data in the bar charts, the hypothesis that aging involves loss of brain cells.   *[2]*

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. . . .

. . . .

. . . .

(d)   Suggest the implications of the data for humans.   *[2]*

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. . . .

. . . .

. . . .

E2. (a) State the missing cell type in the sequence encountered as light enters the retina. *[1]*

| ganglion cells | → | | → | rods and cones |
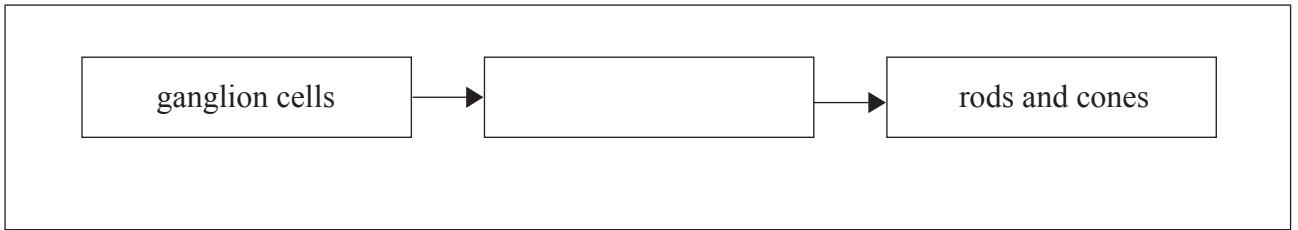
(b) Outline how contralateral processing of visual stimuli occurs in the human eye. *[2]*

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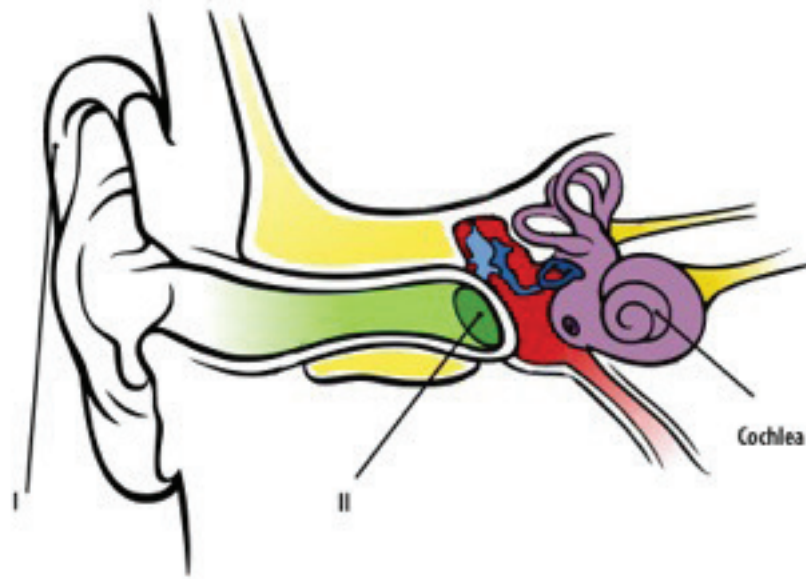
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(Question E2 continued)

(c)   The diagram shows the structure of the human ear.

[Source: © International Baccalaureate Organization 2013]

(i)   Label structures I and II.   *[1]*

> I.   . . . .
>
> II.   . . . .

(ii)   Outline how sounds are perceived in the cochlea, including the name of the cell type involved.   *[1]*

> . . . .
>
> . . . .

Turn over

E3. (a) (i) Define *stimulus*. *[1]*

(ii) State **two** effects that presynaptic neurons can have on postsynaptic transmission. *[1]*

1. . . . .

2. . . . .

(b) Define the behaviour known as taxis. *[1]*

(c) Suggest causes of addiction to drugs. *[3]*

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

Answers written on this page
will not be marked.

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Option F — Microbes and biotechnology

F1. In 2003, the Integrated Approach to Community Development (IACD) organization introduced the chulli water purifier to homes in Bangladesh that had not previously had access to safe drinking water. It was designed to be made cheaply from local materials. The purifier uses sand filtration to remove organic particles and heat treatment to eliminate microbes from water.

Water samples from 15 different locations containing high levels of the bacterium *E. coli* were passed through the purifier at different flow rates and temperatures to test its effect on contaminated water. The shaded area of the graph below represents the recommended temperature and flow rate for using the purifier.
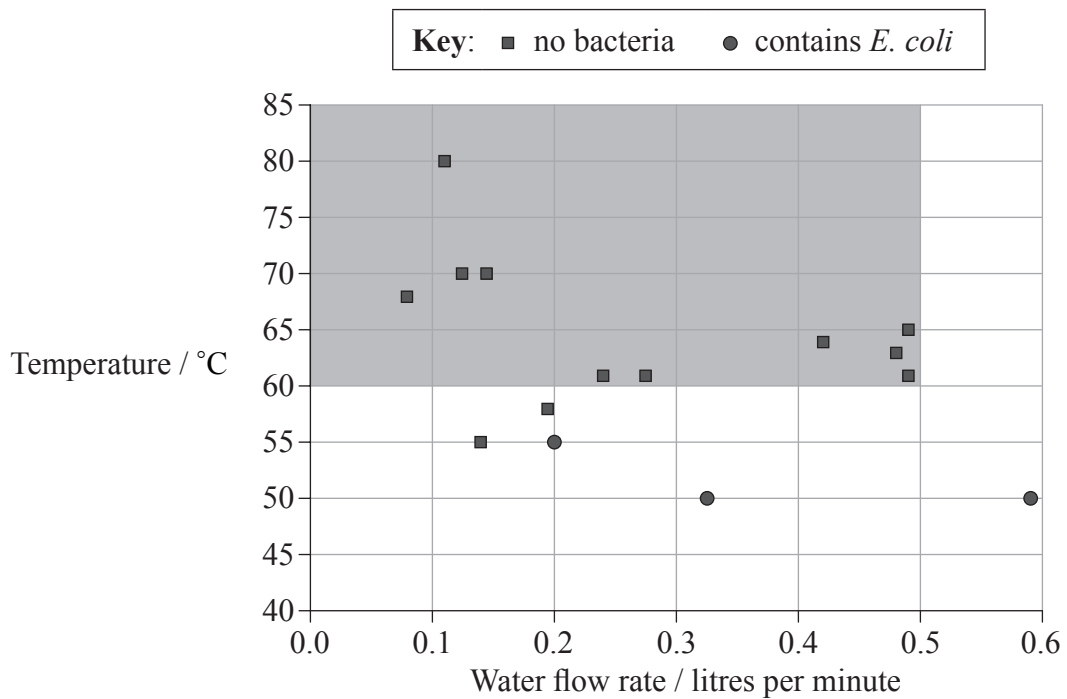
[Source: S. K. Gupta et al. (2008) *American Journal of Tropical Medicine and Hygiene*, 78, pages 979–984]

(a)   State the highest temperature at which bacteria were found in water that had passed through the chulli purifier.   *[1]*

....

(Question F1 continued)

(b) Calculate the maximum volume of safe drinking water that could be produced by the chulli purifier in one hour. *[1]*

. . . .

. . . .

(c) Discuss whether 80 °C is the best temperature to operate the chulli purifier. *[2]*

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. . . .

. . . .

. . . .

(d) The results suggest that there may be a relationship between the water flow rate and the minimum temperature needed to eliminate microbes. State this relationship. *[1]*

. . . .

. . . .

(e) Evaluate the chulli purifier as a method of controlling microbial growth. *[2]*

. . . .

. . . .

. . . .

. . . .

F2. (a) List **two** structural features that vary among viruses. *[2]*

1. ....

2. ....

(b) Explain how Gram staining is used in microbiology. *[3]*

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

(c) Discuss the possible consequences of gene therapy. *[2]*

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

F3. (a)   State **one** soil condition that favours denitrification.   *[1]*

....

(b)   State an extreme feature that occurs in **one** habitat for Archaea.   *[1]*

....
....

(c)   Historically, the use of salt to preserve cod fish has been very important. Outline the use of salt in preserving food.   *[2]*

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

Turn over

Option G — Ecology and conservation

G1. A grassland food web was studied to understand how climate warming affects the interaction of different animal and plant species. Grasshoppers (*Melanoplus femurrubrum*) feed on grasses growing amongst taller bushes. Spiders (*Pisaurina mira*) feed on the grasshoppers. For 75 days, the feeding behaviour of the grasshoppers was observed with and without predators, in temperatures that were cool or warm. During the study period, the grasshoppers progressed through stages of larval development (instars) to adulthood.

Proportion of time spent on feeding
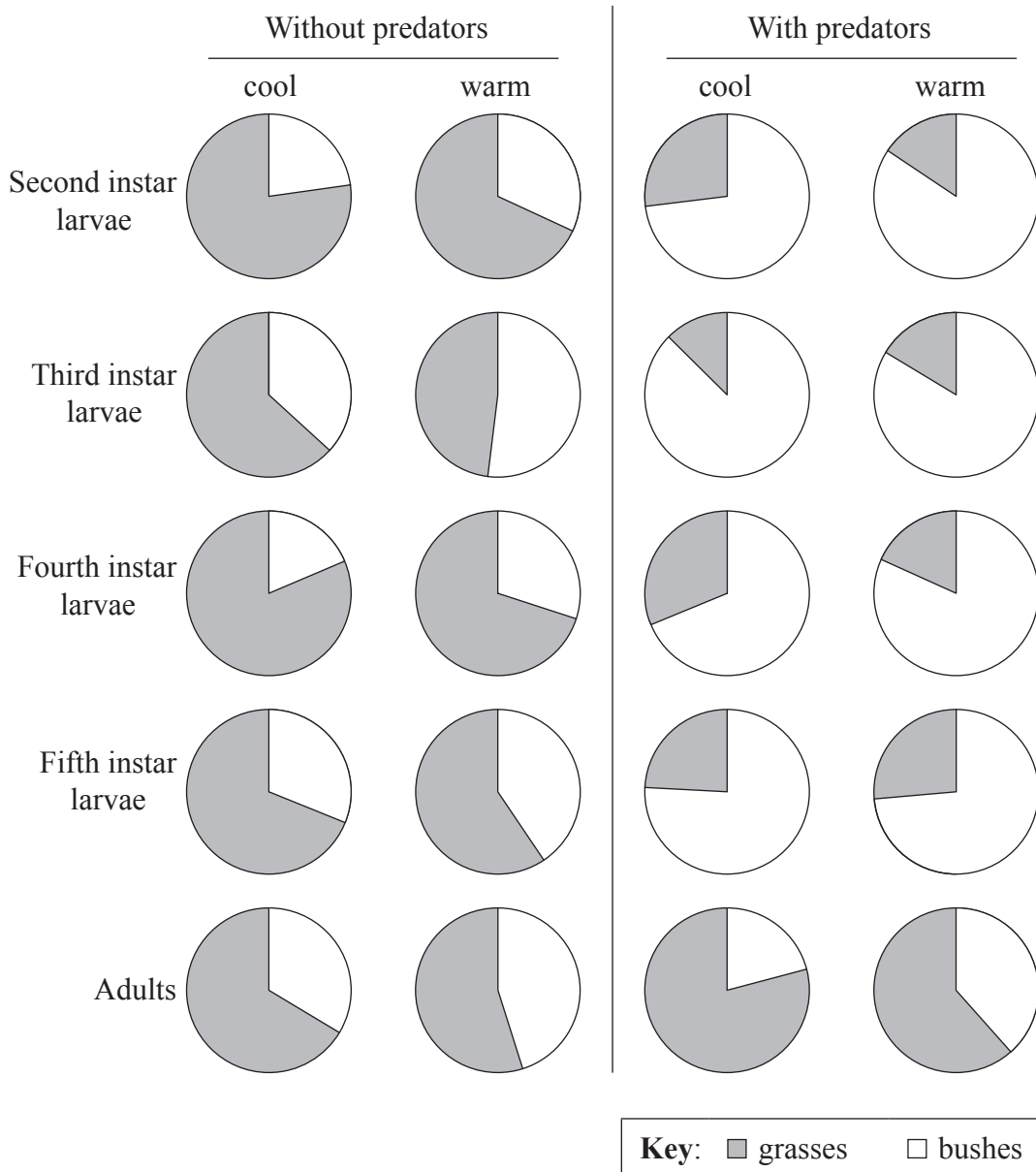
[Source: B. T. Barton (2010) *Ecology*, 91(10), pages 2811–2818. Used by permission of the Ecological Society of America.]

(This question continues on the following page)

(Question G1 continued)

(a)   Identify the primary food for all grasshoppers without predators.   *[1]*

. . . .

(b)   Deduce, using the data, how the feeding behaviour of instar larvae changes if

(i)   without predators, conditions change from cool to warm.   *[1]*

. . . .
. . . .

(ii)   in warm conditions, predators are introduced.   *[1]*

. . . .
. . . .

(c)   Compare adult feeding to instar larval feeding.   *[2]*

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

(This question continues on the following page)

Turn over

(Question G1 continued)

(d)   Suggest why adult feeding differs from instar larval feeding when predators are present.   *[1]*

. . . .

. . . .

(e)   Predict, with a reason, if a warming climate change would favour grasses **or** bushes in this grassland habitat.   *[1]*

. . . .

. . . .

G2. (a) Explain the niche concept. *[3]*

(b) Outline the principle of competitive exclusion. *[2]*

(c) Outline **one** reason for the extinction of a **named** animal species. *[1]*

(d) State **one** use of the Simpson index in ecology. *[1]*

G3. (a)   Distinguish between gross and net production.   *[1]*

> ....
> ....
> ....
> ....

(b)   List **three** negative biological effects of ultraviolet (UV) radiation.   *[3]*

> 1.   ....
>
> 2.   ....
>
> 3.   ....