Biology
Standard level
Paper 3

Tuesday 2 May 2017 (morning)

Section A Questions
Answer all questions. 1 – 3

Section B Questions
Answer all of the questions from one of the options.

<table>
<thead>
<tr>
<th>Option</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option A — Neurobiology and behaviour</td>
<td>4 – 8</td>
</tr>
<tr>
<td>Option B — Biotechnology and bioinformatics</td>
<td>9 – 13</td>
</tr>
<tr>
<td>Option C — Ecology and conservation</td>
<td>14 – 18</td>
</tr>
<tr>
<td>Option D — Human physiology</td>
<td>19 – 22</td>
</tr>
</tbody>
</table>

Instructions to candidates
• Write your session number in the boxes above.
• Do not open this examination paper until instructed to do so.
• Answers must be written within the answer boxes provided.
• A calculator is required for this paper.
• The maximum mark for this examination paper is **35 marks**.

1 hour
Tuesday  2 May 2017 (morning)
Section A

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

1. The oxygen consumption rate of the fish *Oplegnathus insignis* was examined in a respirometer at three different water temperatures and at four different body masses.

![Diagram of respirometer setup]

**Key:**
- ▲ 23 °C
- ■ 18 °C
- ● 13 °C


(a) Suggest how the oxygen consumption rate is determined using this apparatus. [2]

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

(This question continues on the following page)
(Question 1 continued)

(b) State the relationship between body mass and the oxygen consumption of fish. [1]

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

(c) Predict the effects of global warming on aerobic respiration in fish. [2]

...........................................................................................................................
...........................................................................................................................
...........................................................................................................................
...........................................................................................................................
2. Keratin is a protein found in hair, nails, wool, horns and feathers. The graphs show the relative keratinase activity obtained in experiments into keratin digestion at different pH values and different temperatures.

[Graph showing relative activity vs pH and temperature]


(a) Determine the optimum pH and temperature of keratinase. [1]

(b) Suggest two changes occurring in the reaction vessel that could be used to indicate keratinase activity. [2]

(c) State two conditions that should be kept constant in both experiments. [2]
Please do not write on this page.

Answers written on this page will not be marked.
3. In an experiment to determine the effect of diet on response to leptin, mice were fed a control diet or a high fructose diet for six months and then either injected with a saline (salt) solution or injected with leptin. The food intake of both groups was then monitored over a 24 hour period.

(a) Distinguish between the effect of leptin injection on 24 hour food intake in the mice fed the control diet and in the mice fed the high fructose diet. [1]

(Removed for copyright reasons)

(This question continues on the following page)
(Question 3 continued)

(b) Discuss the implications of these results for recommending leptin injections as an appetite suppressant for humans. [2]

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

(c) Leptin is a hormone. Hormones are chemicals produced in one part of the body that have an effect in another part of the body. State the

(i) tissue that produces leptin in humans. [1]

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

(ii) target that leptin normally acts on. [1]

..........................................................................
Section B

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

Option A — Neurobiology and behaviour

4. The images show the early stages and completed outcome of the process of neurulation.

Early stages

[Source: adapted from www.slideshare.net]

(a) Label the parts I and II on the images. [2]

(b) Structure Y will eventually elongate to form two structures. State the names of these two structures. [2]

1. .................................................................

2. .................................................................

(Optional A continues on the following page)
(Option A, question 4 continued)

(c) State the condition that arises if the closure of structure X is incomplete during embryonic development. [1]

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

5. (a) Outline the function of the autonomic nervous system in the human body. [2]

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

(b) Evaluate the use of the pupil reflex to test for brain damage. [3]

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

(Option A continues on the following page)
6. The graph shows the relationship between body mass and brain volume in three groups of primates.

![Graph showing brain volume vs. body mass for different primates.]

**Key:** 
- Homo
- Australopithecines
- Apes

[Source: adapted from G Roth and U Dicke (2005) *TRENDS in Cognitive Sciences*, 9 (5), with permission from Elsevier]

Analyse the relationship between body mass and brain volume in these primates. [3]
(Option A continued)

7. The diagram shows a photoreceptor and an olfactory receptor. The arrows show the direction of the stimulus.

[Source: adapted from A Louvi and E A Grove (2011) Neuron, 69 (6), pages 1046–1060, with permission from Elsevier]

(a) State the name of the photoreceptor shown. [1]

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

(b) Distinguish between a photoreceptor and an olfactory receptor. [2]

<table>
<thead>
<tr>
<th></th>
<th>Photoreceptor</th>
<th>Olfactory receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulus perceived</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tissue where it is found</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Option A continues on the following page)
(Option A continued)

8. Explain how information from the left and right sides of the visual field is processed. [4]

End of Option A
Option B — Biotechnology and bioinformatics

9. The diagram shows a biofilm that has formed on a tooth.

Using the diagram, explain the concept of emergent properties of biofilms. [3]

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

(Option B continues on the following page)
10. Starch from different sources contains differing proportions of amylose and amylopectin. Potatoes (*Solanum tuberosum*) have been genetically modified to produce high-amylopectin starch (Amflora potatoes). Heat induces starch to form a gel in excess water. The graph shows gel formation temperature at different amylose concentrations.

![Graph showing gel formation temperature at different amylose concentrations.]

(a) Discuss the hypothesis that the temperature at which starches form a gel depends on the degree of cross-linking of amylopectin. [2]

(b) State one advantage of potatoes with a high amylopectin content. [1]
(Option B, question 10 continued)

(c) The Amflora potato was approved for industrial applications in the European Union (EU) in 2010 and was withdrawn in January 2012 due to opposition. Discuss reasons for people supporting or opposing the introduction of the Amflora potato in the EU. [3]

11. Golden rice is a genetically modified variety of rice (Oryza sativa). The golden colour comes from beta-carotene, a precursor of vitamin A, in the edible parts of rice. The modification was achieved by the addition of two beta-carotene biosynthesis genes, one from a flower (Narcissus pseudonarcissus) and the other from a soil bacterium (Erwinia uredovora).

(a) Using this information, outline the reason for Golden rice being considered a transgenic organism. [1]

(b) Outline the bioinformatics method used to identify the target gene in the plant. [1]
12. The diagram shows a batch fermentation system to monitor and control the production of lipase by the fungus *Candida rugosa*.

(a) Reservoir jar 1 contains antifoam and reservoir jar 2 contains acid. State **two** other substances required for batch fermentation. [2]

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

(b) State what probe X could be used to detect, other than pH or foam formation. [1]

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

(Option B continues on the following page)
(Option B, question 12 continued)

(c) Distinguish between batch fermentation and continuous fermentation. [2]

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

13. Explain how microorganisms can be used in response to pollution incidents such as an oil spill. [4]

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

End of Option B
Option C — Ecology and conservation

14. *Paramecium aurelia* and *Paramecium caudatum* are single cell organisms. They were grown separately and together. The population growth curves are shown.

![Population growth curves for *P. aurelia* and *P. caudatum*](source)

Explain the results shown in this experiment. [3]

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

(Option C continues on the following page)
15. The net primary productivity is the rate at which all the plants in an ecosystem convert energy to biomass. The graphs show the effect of temperature and precipitation in different environments on the net primary productivity.

(a) Distinguish between the effects of temperature and precipitation on net primary productivity. [1]

(b) Tundra ecosystems have temperatures below 0°C and very dry weather. Identify the approximate net primary productivity in Tundra ecosystems. [1]

(c) The points labelled X and Y on the graphs represent the same ecosystem. Deduce the type of ecosystem from the mean annual temperature and precipitation values. [1]
16. The pyramid of biomass obtained from a pine forest stream includes the parasite biomass. Parasites are fungi, worms and other organisms that live on a host.


(a) Estimate the approximate amount of biomass represented by parasites in this ecosystem. [1]

(b) Compare and contrast the biomass in the different trophic levels. [2]

(c) Outline the reason that parasite biomass occurs in both tertiary consumers and secondary consumers. [1]
17. The fire ant (*Solenopsis geminata*) is an effective colonizer and has become invasive in a number of ecosystems. Sometimes, efforts to eliminate this species have had an unexpected impact on community structure. It is argued that *S. geminata* can play a beneficial role in corn production. The graph shows how the presence of *S. geminata* can impact insect diversity in areas where crops of corn are grown.

![Graph showing impact of *S. geminata* on insect species diversity.](source)

(a) State the impact of *S. geminata* on insect species diversity. [1]

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

(b) Discuss whether *S. geminata* might play a positive role in corn production. [3]

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

(Option C continues on the following page)
(Option C, question 17 continued)

(c) Researchers have argued that *S. geminata* is a keystone species in the corn agricultural system. Outline what is meant by a keystone species. [2]

---

18. Explain the use of indicator species to assess the condition of the environment. [4]

---

End of Option C
Option D — Human physiology

19. The diagram shows a cell in the lining of the stomach.

(a) Outline the importance of the proton pumps in the digestion of foods. [2]

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

(b) Explain the use of proton pump inhibitors to treat patients complaining of stomach pain. [3]

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

(Option D continues on the following page)
20. Rats were injected with antibodies that induced phagocytosis of red blood cells (erythrocytes) leading to their breakdown. The graph shows the percentage of intact and partially digested erythrocytes in cells of the liver as observed under the microscope.

![Graph showing percentage of liver cells containing erythrocytes over time.]

**Key:** □ intact erythrocytes □ partially digested erythrocytes


(a) State the name of the cells that perform the breakdown of erythrocytes in the liver. [1]

(b) Describe the breakdown of erythrocytes by liver cells. [3]
(Option D, question 20 continued)

(c) Outline the fate of the iron from the erythrocytes. 

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

21. The diagram shows the use of a sphygmomanometer in the measurement of blood pressure.

(a) Identify the systolic pressure and diastolic pressure for this adult male. 

Systolic pressure (mm Hg): ....................................................
Diastolic pressure (mm Hg): ....................................................

(b) Explain the meaning of systolic and diastolic pressure. 

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

[Source: adapted from CA Villee, (1972), Biology, Sixth Edition, page 357]
(Option D, question 21 continued)

(c) The photomicrograph shows cardiac muscle. Label the structures I and II. [2]

I. ..................................
II. ..................................

[Source: https://en.wikipedia.org/wiki/Cardiac_muscle#/media/File:Glanzstreifen.jpg]

22. Explain a method to quantify the energy content in food. [4]

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

End of Option D
Please do not write on this page.

Answers written on this page will not be marked.
Please do not write on this page.

Answers written on this page will not be marked.