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BIOLOGY
HIGHER LEVEL
PAPER 3

Candidate session number

| 0 | 0 | | | | | | | | |

Friday 18 May 2012 (morning)

1 hour 15 minutes

Examination code

| 2 | 2 | 1 | 2 | – | 6 | 0 | 0 | 9 |

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 D — Evolution

D1. A study of the changing frequencies of the melanic (dark) and non-melanic (light) forms of three moth species *Biston betularia*, *Odontoptera bidentata* and *Apamea crenata* was carried out in the north of England. Moths were captured using mercury vapour light traps throughout the flying season. All three of the moth species fly at night and rest in the day, when they would be vulnerable to predation by birds, if visible. *B. betularia* rests on tree branches and there is evidence that the change from melanic to non-melanic forms was associated with black soot disappearing from these branches as air pollution was reduced and pale coloured lichens started to grow. *O. bidentata* rests under the leaves of trees or in cracks in tree bark. *A. crenata* rests in long grasses. The graph shows the percentage of melanic moths caught between 1969 and 2002.
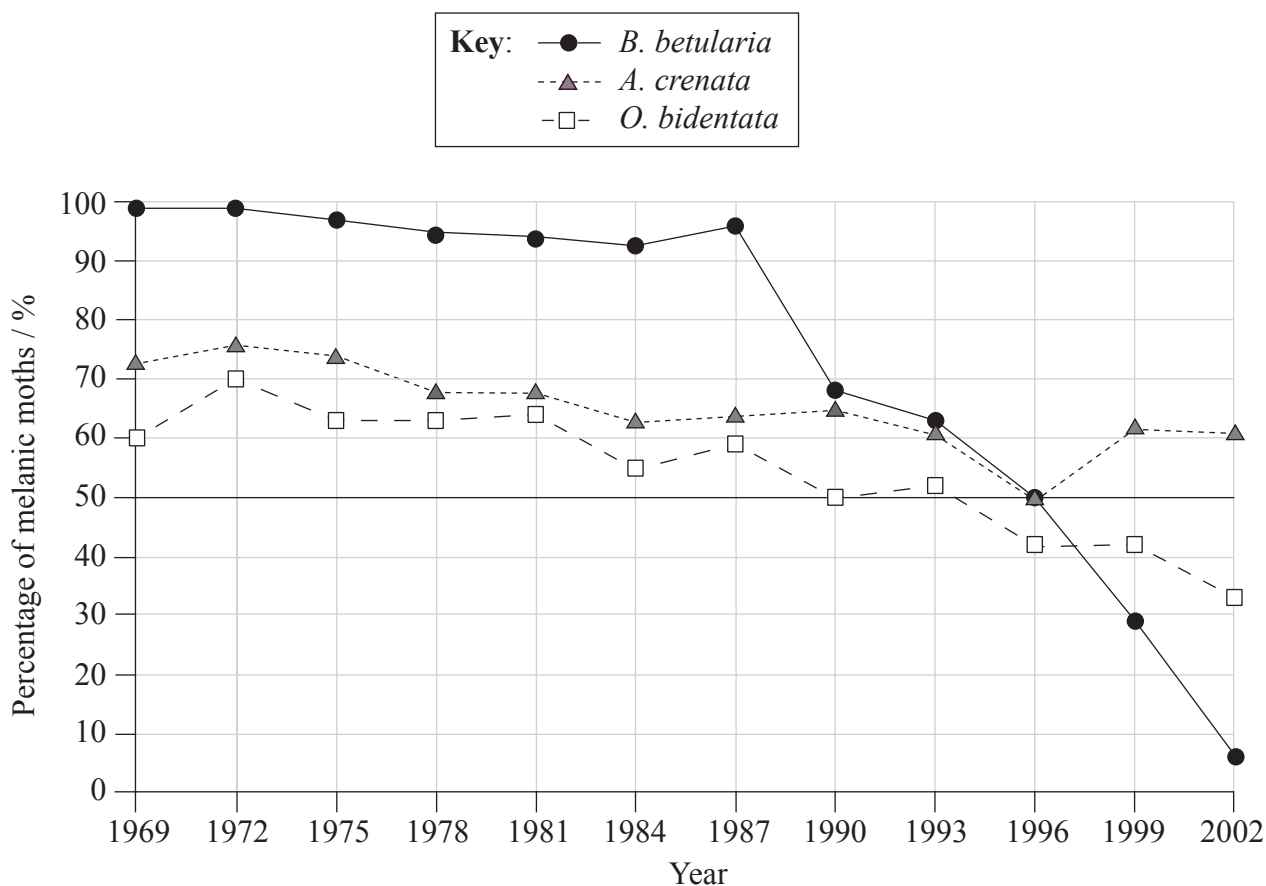
(a) Identify the year with the highest frequency of the melanic form of *O. bidentata*. *[1]*

....

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(Question D1 continued)

(b)   Estimate the percentage of **non-melanic** forms of *A. crenata* in 1978.   *[1]*

(c)   (i)   Compare the trends for the three moth species during the study.   *[3]*

        (ii)   Suggest reasons for the differences in trends.   *[2]*

D2. (a)   State **one** activity of RNA necessary for it to have had a role in the origin of life.   *[1]*

....

(b)   (i)   In a human population allele A is dominant to allele a. Calculate the frequency of the resulting phenotypes if the frequency of allele A is 0.9.   *[3]*

....

(ii) State **one** condition required for the use of the Hardy-Weinberg equation to be valid.   *[1]*

....

(c)   Distinguish between analogous and homologous structures.   *[2]*

Analogous structures	Homologous structures

D3. Discuss the relative contributions of genetic and cultural evolution to recent human evolution.   *[6]*

Turn over

Option E — Neurobiology and behaviour

E1.   The drug cocaine is believed to have an impact on fetal development. A study was carried out to evaluate the relationship between head circumference and birth weight in newborn babies exposed to cocaine when they were in the uterus.

Cocaine levels were measured in the mothers during pregnancy and the mothers were categorized into three study groups: no cocaine, low cocaine and high cocaine. Head circumference and birth weight were measured in the babies and their relationship is presented in the graph below.

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[http://pediatrics.aappublications.org/content/106/3/e33.full.pdf+html]

(a)   State the lowest head circumference measured in newborn babies born to high cocaine users, giving the units.   *[1]*

....

(This question continues on the following page)

(Question E1 continued)

(b)   State the relationship between birth weight and head circumference in newborn babies whose mothers did not use cocaine. *[1]*

. . . .

. . . .

(c)   Using the data in the graph, describe the relationship between cocaine exposure and head circumference in newborn babies. *[2]*

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(d)   Deduce the effect of cocaine use on the head circumference of babies with a birth weight below 3.5 kg. *[2]*

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E2. (a) Distinguish between innate and learned behaviour. *[1]*

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. . . .

. . . .

(b) State the name of the part of the brain that coordinates balance. *[1]*

. . . .

(c) Label the diagram of the ear. *[2]*

IV. . . . .

III. . . . .

II. . . . .

I. . . . .
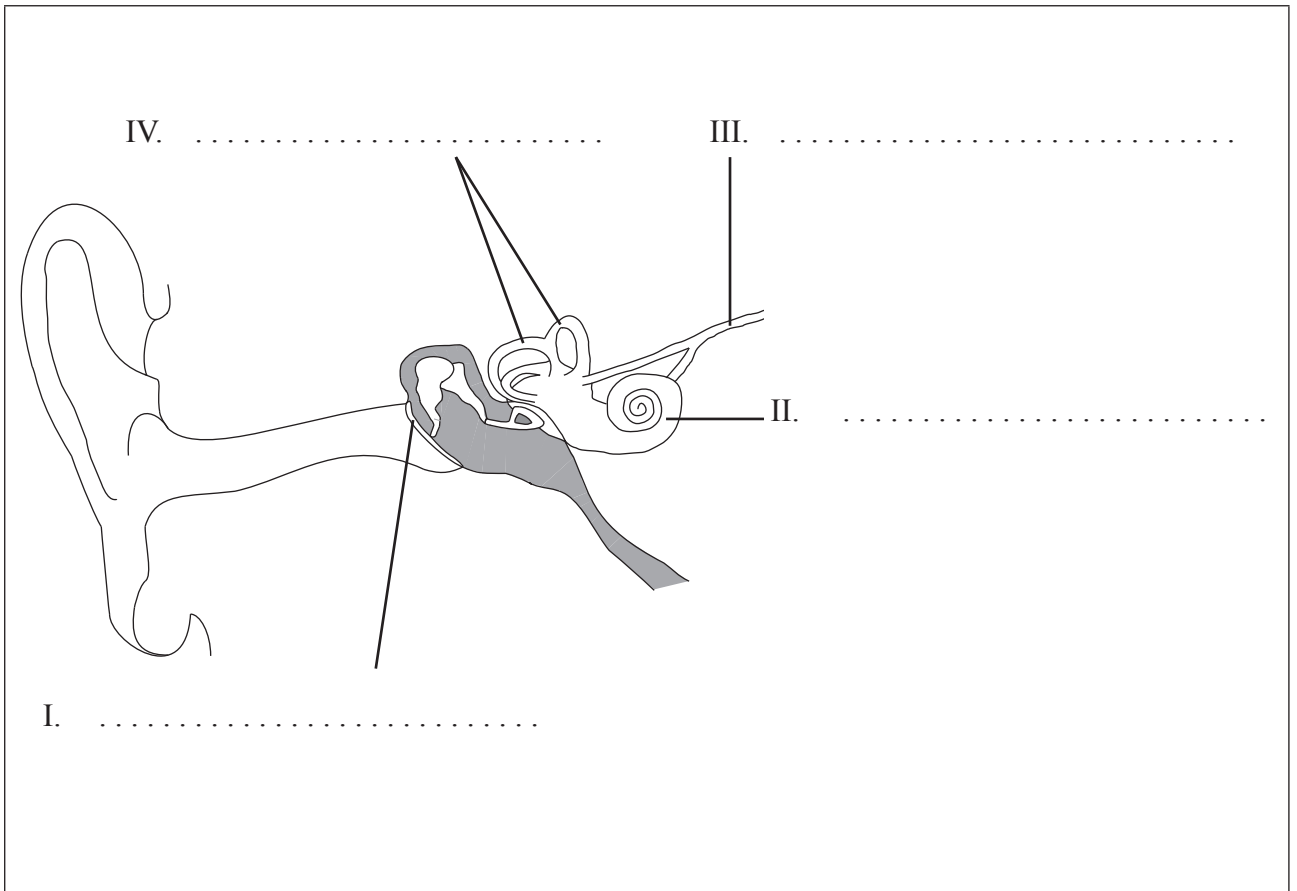
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(Question E2 continued)

(d)   Compare the effects of the sympathetic and parasympathetic nervous systems with reference to examples. *[4]*

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E3. Describe the social organization of honey bee colonies.   *[6]*

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Option F — Microbes and biotechnology

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(Question F1 continued)

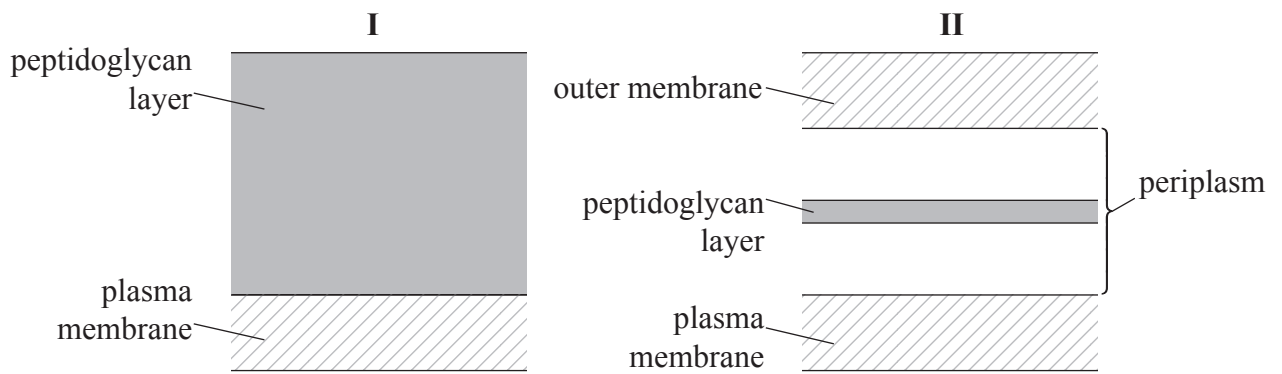Content removed for copyright reasons.

Turn over

F2. (a)   Define *epidemiology*.   *[1]*

> ....
> ....

(b)   The diagram below represents the cell walls of two different bacteria. State, with a reason,
which cell wall (I or II) is Gram-positive.   *[1]*

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

(c)   Microorganisms play many roles in ecosystems. List **two** of these roles.   *[2]*

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

(This question continues on the following page)

(Question F2 continued)

(d)   Compare photoautotrophic and photoheterotrophic microorganisms.   *[3]*

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Turn over

F3. Describe the cause, transmission and effects of malaria. *[6]*

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Option G — Ecology and conservation

G1. Mercury is a toxic substance and its biomagnification in aquatic food chains is a global concern. A study tested the effects of inorganic phosphorus levels on both algal growth and mercury accumulation by *Daphnia mendotae* feeding on the algae which absorb mercury from the water. *Daphnia* may subsequently be eaten by fish.

Experiments were performed in six different tanks with increasing phosphorus concentrations. The same amount of mercury was added to each tank. The quantity of algae, determined by measuring the amount of chlorophyll a, and the accumulation of mercury by *Daphnia* was measured in each tank. Chlorophyll a and mercury levels were measured twice at each of the six different phosphorus concentrations.
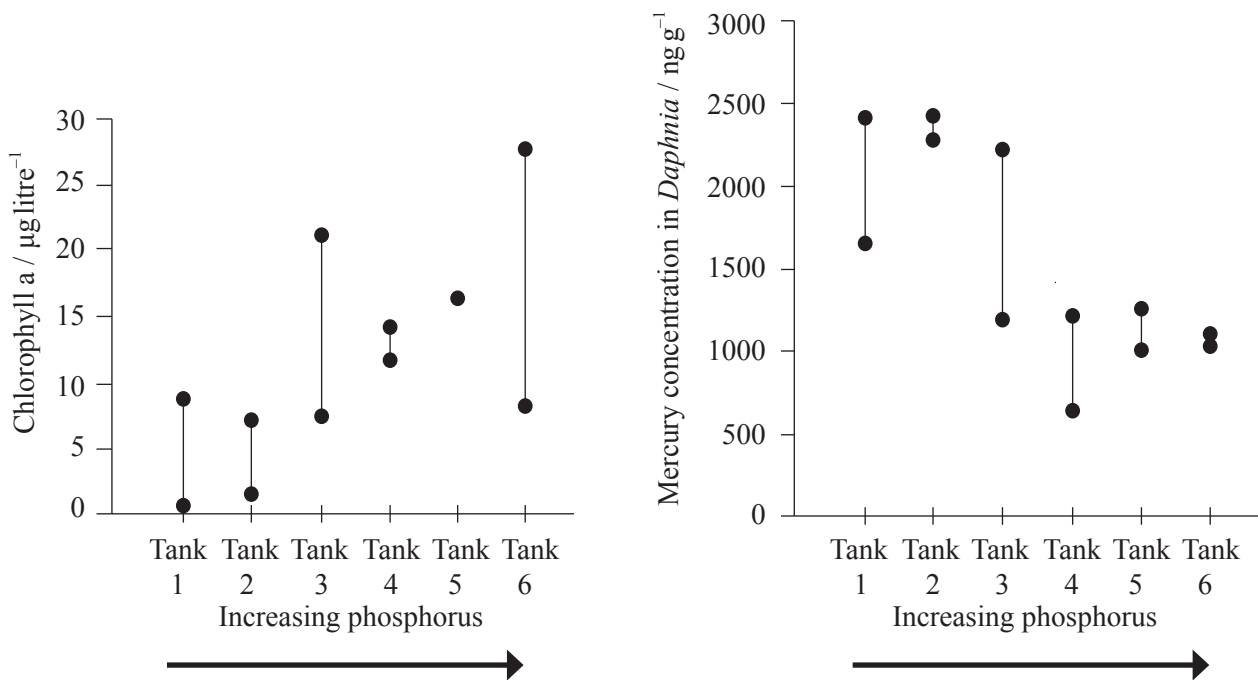
[Source: adapted from Paul C. Pickhardt, Carol L. Folt, Celia Y. Chen, Bjoern Klaue and Joel D. Blum (2002) 'Algal blooms reduce the uptake of toxic methylmercury in freshwater food webs'. PNAS, 99, pp. 4419–4423. Figures 2A and 3C]

(a) (i) Deduce the tank in which the quantity of algae was highest. *[1]*

....

(This question continues on the following page)

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(Question G1 continued)

    (ii)   Deduce the tank in which the level of mercury accumulation in *Daphnia* was lowest. *[1]*

(b)   Outline the relationship between phosphorus concentration in the water and the accumulation of mercury by *Daphnia*. *[2]*

(c)   Using the data, suggest reasons for the relationship between phosphorus concentration in the tanks and mercury concentration in *Daphnia*. *[2]*

Turn over

G2. (a) In a grassland ecosystem, the amount of energy captured by the photosynthetic organisms was $100\,000\,kJ\,m^{-2}\,yr^{-1}$. Construct a pyramid of energy indicating the predicted energy levels for **four** trophic levels, including the producers. *[3]*

(b) Define *biomass*. *[1]*

. . . .

. . . .

(c) Distinguish between r-strategies and K-strategies. *[2]*

. . . .

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(d) Outline a **named** example of a mutualistic interaction. *[2]*

. . . .

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G3. Discuss the advantages of *in situ* conservation of endangered species, using examples.   *[6]*

Option H — Further human physiology

H1. The diameter of the femoral artery in response to bicycle exercise was tested in ten non-smoking and eight smoking male subjects. During an exercise period of 40 minutes the femoral artery was periodically scanned in longitudinal sections by high-resolution ultrasound.

The exercise period was started with a constant workload of 100 W for 20 minutes. Thereafter the workload was increased to 150 W for another 20 minutes. Immediately after the exercise period, the subjects remained in the sitting position for another 30 minutes to obtain post-exercise measurements.
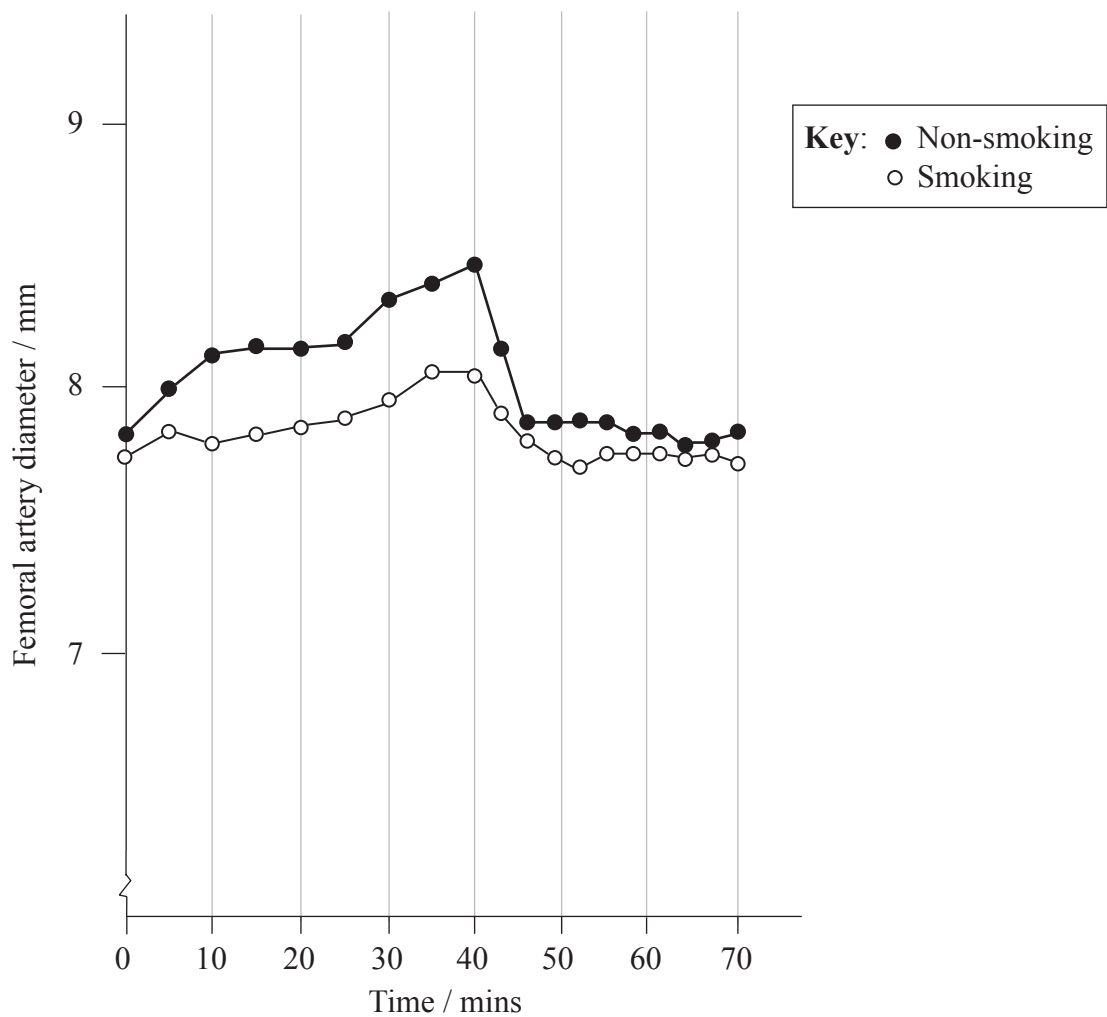
[Reprinted from *Journal of the American College of Cardiology*, 38 (5), H. Gaenzer, G. Neumayr, P. Marschang, W. Sturm, R. Kirschmair and J. R. Patsch, 'Flow-mediated vasodilation of the femoral and brachial artery induced by exercise in healthy nonsmoking and smoking men', pp. 1313–1319, ©2001, with permission from Elsevier.]

(This question continues on the following page)

(Question H1 continued)

(a)   State how long it took after the completion of exercise for the femoral artery diameter of
smokers to return to its original value.   *[1]*

.... mins

(b)   Compare the results for smokers and non-smokers.   *[3]*

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

(c)   Suggest possible conclusions from this experiment related to human health.   *[2]*

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....

H2. (a) In healthy adults, there are heart sounds during the cardiac cycle. Outline the causes of **two** of these sounds. *[2]*

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. . . .
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. . . .

(b) State **two** products resulting from the breakdown of erythrocytes (red blood cells) in the liver. *[2]*

1. . . . .

2. . . . .

(c) Compare gastric juice and pancreatic juice. *[3]*

	Gastric juice	Pancreatic juice
Acidity or alkalinity		
Enzymes		
Site of action		

(d) List **one** material that is egested after human digestion. *[1]*

. . . .

H3. Explain the oxygen dissociation of **myoglobin**, completing the graph below to support your answer. Po$_2$ is the partial pressure of oxygen. *[6]*

O$_2$ saturation / %

100

80

60

40

20

0

0   5   10   15

Po$_2$ / kPa

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