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BIOLOGY
HIGHER LEVEL
PAPER 3

Candidate session number

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Friday 18 May 2012 (morning)

1 hour 15 minutes

Examination code

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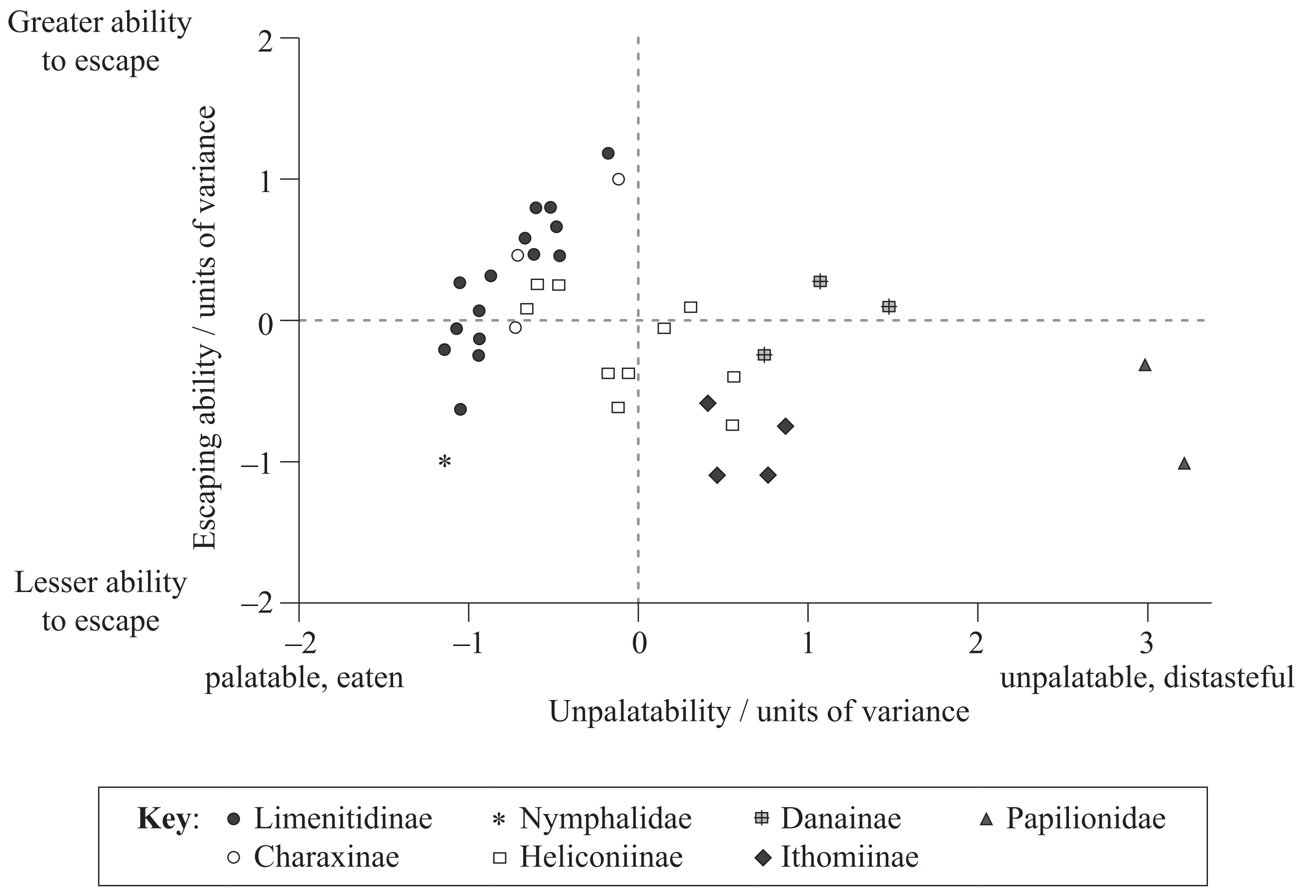
INSTRUCTIONS TO CANDIDATES

- 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 D — Evolution

D1. Butterflies have evolved different methods of defence against bird attacks. The relative escaping ability and unpalatability (distastefulness) of different tropical butterfly families and subfamilies was investigated in the presence of wild kingbirds, *Tyrannus melancholicus*, a natural predator of butterflies. Each symbol on the graph represents a different species within a (sub)family.



['Palatability and escaping ability in Neotropical butterflies: tests with wild kingbirds (Tyrannus melancholicus, Tyrannidae).' *Biological Journal of the Linnean Society*, **59**, pp. 351−365, Carlos E.G. Pinheiro. ©1996 Linnean Society. Reproduced with permission of Blackwell Publishing Ltd.]

(a) State which butterfly (sub)family contains the species with the greatest escaping ability. *[1]*

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(This question continues on the following page)

(Question D1 continued)

(b) Suggest **one** feature of butterfly wings that might help a butterfly to escape from a predator. *[1]*

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(c) (i) Explain how the ability of a butterfly to escape from predators could increase by natural selection. *[3]*

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(ii) The graph shows that distasteful butterflies tend to have a lower ability to escape from predators than palatable butterflies. Suggest reasons for this trend. *[2]*

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D2. (a) Outline the use of **two named** radioisotopes for dating fossils. *[2]*

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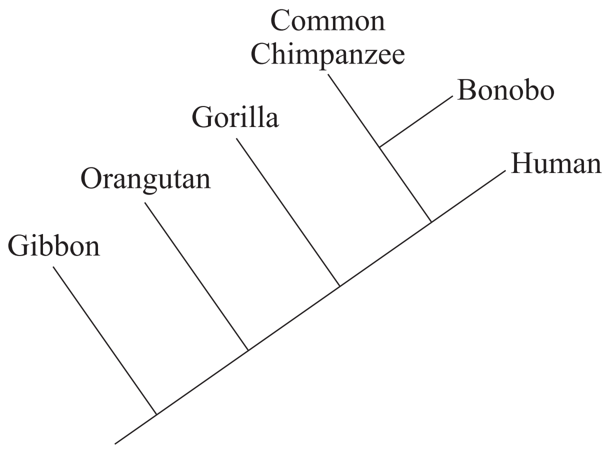
(b) The diagram below is a cladogram.



Identify the

(i) **two** most closely related organisms. *[1]*

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(ii) species to which the Bonobo is most distantly related. *[1]*

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(Question D2 continued)

(c) Describe **one** type of barrier that may exist between gene pools. *[3]*

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D3. Discuss the relative importance of genetic and cultural evolution in the recent evolution of humans. *[6]*

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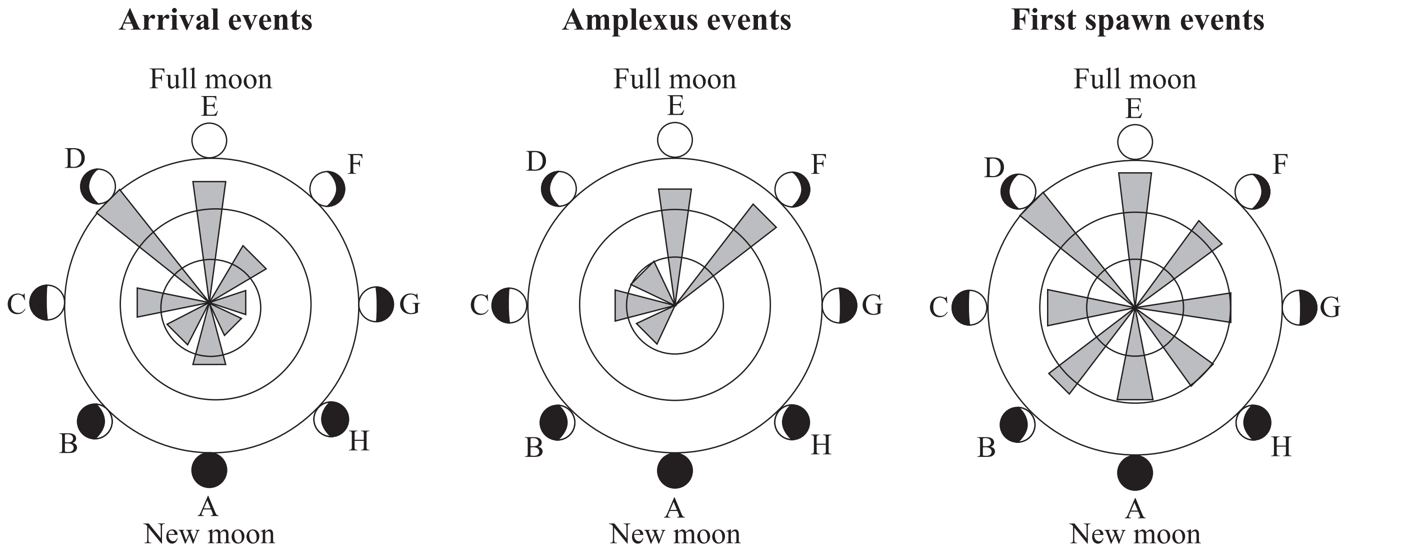
will not be marked.

Option E — Neurobiology and behaviour

E1. Each spring, the breeding season for various species of toads begins with a mass arrival of females at ponds and lakes. Males arrive later and actively compete for the females. Amplexus (mating embrace) and spawning (depositing eggs in water) then follow. Many environmental variables affect the timing of breeding. The hypothesis that periodicity in reproductive behaviour reflects periodicity in the lunar cycle was tested over several breeding seasons at sites in Wales (UK) and Italy. The lengths of the shaded bars indicate the relative frequencies of the events.



[Reprinted from Animal Behaviour, vol. 78 (2), Rachel A. Grant, Elizabeth A. Chadwick and Tim Halliday, 'The lunar cycle: a cue for amphibian reproductive phenology?', pp 349–357, ©2008 . With permission from Elsevier.]

(a) Identify which reproductive event is least influenced by the lunar cycle. *[1]*

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(Question E1 continued)

(b) Compare the data for arrival events with amplexus events. *[2]*

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(c) Deduce the relationship between arrival events and amplexus events in moon phases D to F. *[1]*

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(d) The lunar cycle could affect the timing of breeding. Suggest, with a reason, **one** other environmental variable which could affect the timing. *[2]*

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E2. (a) State a function of each of the following parts of the human brain.

(i) Cerebellum *[1]*

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(ii) Hypothalamus *[1]*

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(b) Describe how decision-making in the central nervous system (CNS) can result from the interaction between the activities of excitatory and inhibitory presynaptic neurons at synapses. *[3]*

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(Question E2 continued)

(c) Outline the effects of cocaine at synapses in the brain. *[3]*

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E3. Discuss the evolution of altruistic behaviour using **two** non-human examples. *[6]*

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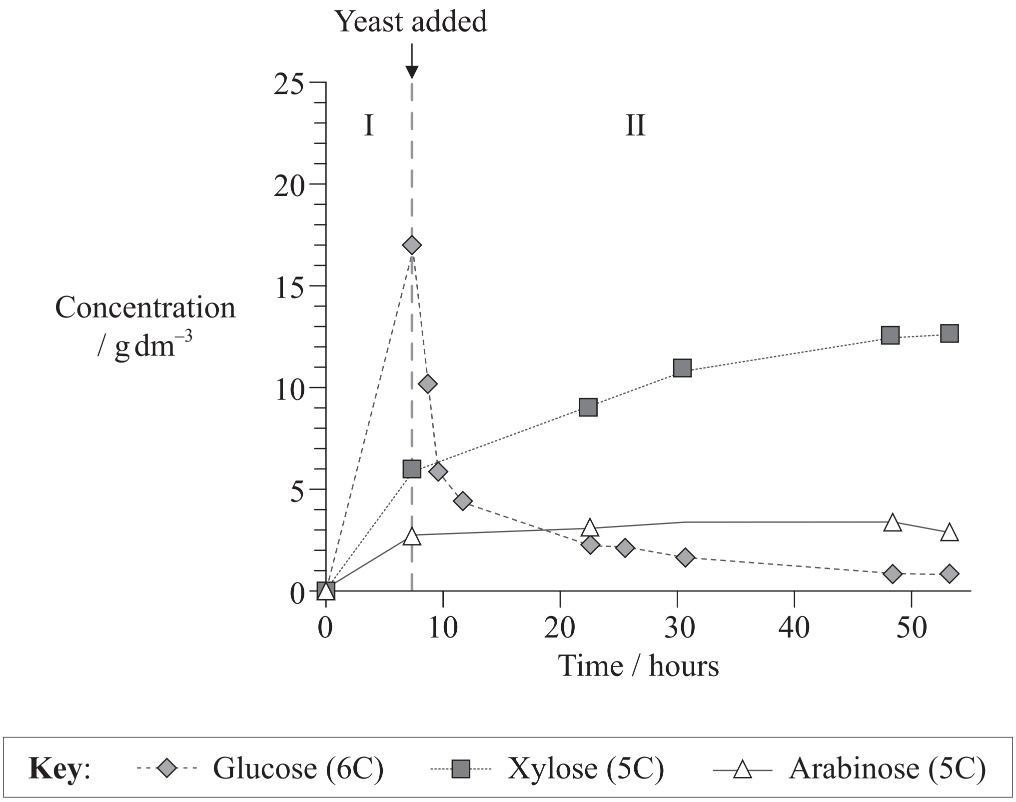
Option F — Microbes and biotechnology

F1. Ethanol is an alternative energy source. Wheat straw can be converted into ethanol in two phases. Hydrolysis of complex polysaccharides in wheat straw (phase I) produces three monosaccharides (glucose, xylose and arabinose). Fermentation by yeast (*Saccharomyces cerevisiae*) then produces ethanol (phase II). The graph shows the changes in concentration of the three monosaccharides in both phases.



[Adapted from: Ronald H.W. Maas, Robert R. Bakker, Arjen R. Boersma, Iemke Bisschops, Jan R. Pels, Ed de Jong, Ruud A. Weusthuis and Hans Reith (2008) 'Pilot-scale conversion of lime-treated wheat straw into bioethanol: quality assessment of bioethanol and valorization of side streams by anaerobic digestion and combustion'. *Biotechnology for Biofuels*, 1, p. 14, Figure 1 (A). Covered by a Creative Commons licence: http://creativecommons.org/licenses/by/2.0/]

(a) State the maximum concentration of glucose reached during the two phases, giving the units. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(b) Distinguish between the changes in concentration of xylose and arabinose in phase II. *[2]*

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(c) Explain the changes in concentration of glucose and xylose during phase II. *[3]*

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(d) Suggest an advantage of the use of wheat straw as a source of energy. *[1]*

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F2. (a) State, giving **one** specific example, how individual bacteria change their characteristics when they form aggregates. *[2]*

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(b) List **two** traditional methods used by people to preserve food. *[2]*

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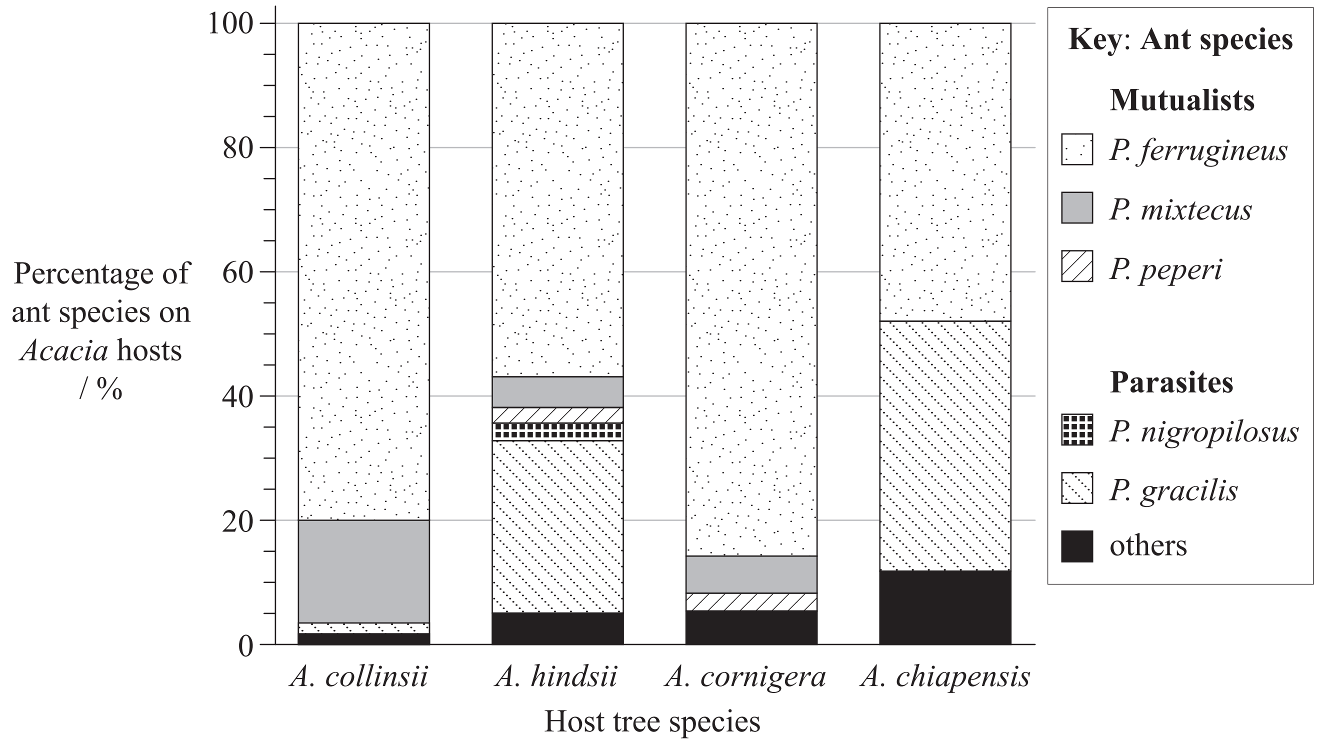
(c) Using the table, distinguish between chemoautotrophs, photoheterotrophs and chemoheterotrophs. *[3]*

	Energy sources	**Carbon sources**
chemoautotrophs	. . . .	. . . .
photoheterotrophs	. . . .	. . . .
chemoheterotrophs	. . . .	. . . .

F3. Evaluate the control of microbial growth through irradiation and antiseptics. *[6]*

Option G — Ecology and conservation

G1. Mutualisms are interactions between different species that provide benefits for both partners. A study was undertaken of the mutualism between four species of the host tree *Acacia* and six species of the ant *Pseudomyrmex*. Mutualistic ant species were compared to parasitic ant species of the same genus. Both groups of ants live inside the hollow thorns of the *Acacia* and eat the extrafloral nectar produced by the tree. Mutualistic ant species defend the *Acacia* from herbivores, while parasitic ant species do not.



[Source: adapted from: Martin Heil, Marcia González-Teuber, Lars W. Clement, Stefanie Kautz, Manfred Verhaagh and Juan Carlos Silva Buenoa (2009) 'Divergent investment strategies of Acacia myrmecophytes and the coexistence of mutualists and exploiters'. PNAS, 106, pp. 18 091–18 096, Figure 1]

(a) (i) Identify the species of ant that was most common on **all** four species of *Acacia*. *[1]*

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(ii) Identify the *Acacia* species that had the greatest percentage of parasitic ants on it. *[1]*

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(This question continues on the following page)

(Question G1 continued)

(b) Calculate the percentage of mutualistic species on *A. hindsii*. *[1]*

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(c) Further studies showed the *A. collinsii* and *A. cornigera* have more thorns per centimetre of shoot and produce more extrafloral nectar than the other two species of *Acacia*. Suggest how these adaptations benefit

(i) the mutualistic ants. *[1]*

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(ii) the *Acacia*. *[1]*

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(d) Using the data, deduce the relationships between the mutualistic and parasitic species of *Pseudomyrmex*. *[2]*

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G2. (a) Outline changes in species diversity during primary succession. *[2]*

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(b) Describe a method used to estimate the size of a mouse population. *[3]*

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(c) (i) Describe the environmental impact of a **named** invasive alien species. *[1]*

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(ii) State an example of biological control of the invasive alien species named in (c)(i). *[1]*

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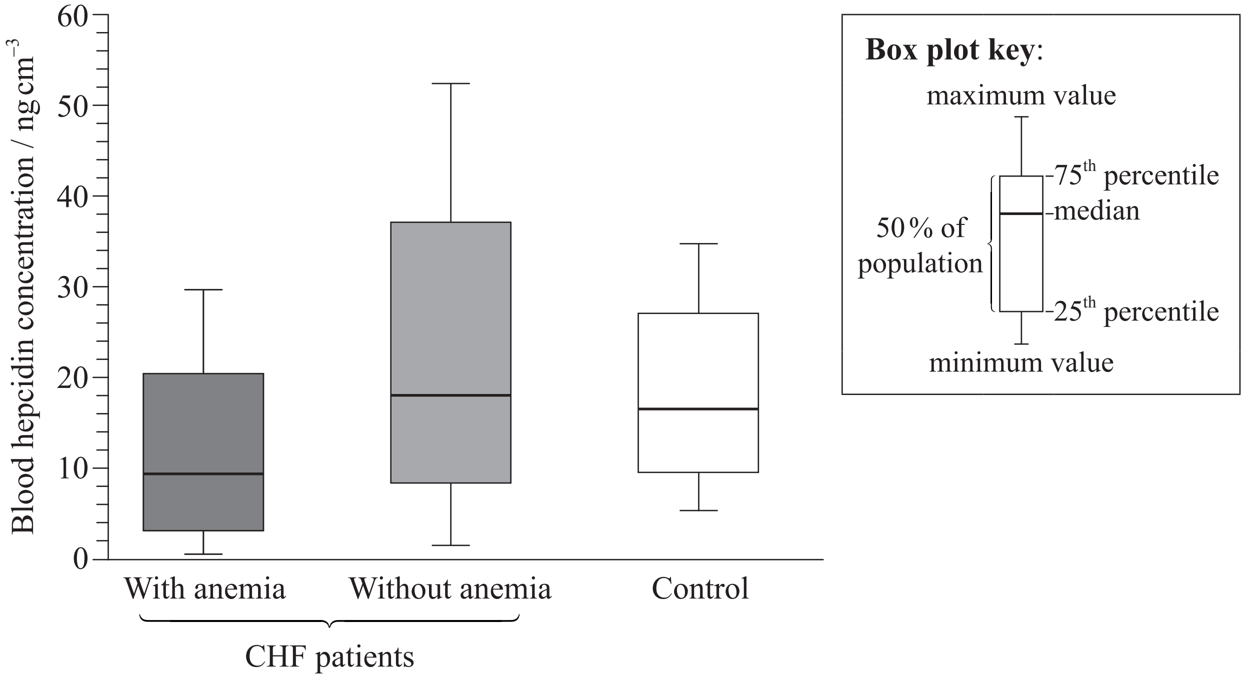
G3. Explain, with examples, the use of specific indicator species and biotic indices to detect changes in the environment. *[6]*

Option H — Further human physiology

H1. In patients with coronary heart failure (CHF), the presence of anemia can increase the risk of mortality. Anemia is a shortage of red blood cells or a reduced concentration of hemoglobin in the blood. Hepcidin is a peptide that is synthesized in the liver to suppress iron absorption in the intestine. The blood hepcidin concentration in CHF patients with anemia and without anemia was measured. The control group did not have cardiac disease or anemia.



[Source: Matsumoto *et. al*, Iron Regulatory Hormone Hepcidin Decreases in Chronic Heart Failure Patients With Anemia, *Circulation Journal*, December 18, 2009. Reproduced with permission.]

(a) State which group has the greatest range of blood hepcidin concentration. *[1]*

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(b) Calculate the difference in median blood hepcidin concentration for CHF patients with anemia and without anemia, giving the units. *[1]*

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(This question continues on the following page)

(Question H1 continued)

(c) Using the data, deduce whether the incidence of CHF **or** the incidence of anemia has a greater effect on the blood hepcidin concentration. *[3]*

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(d) Iron is necessary for hemoglobin to carry oxygen so low iron levels cause low levels of hemoglobin. Suggest reasons for the levels of hepcidin found in CHF patients with anemia. *[2]*

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H2. (a) (i) State **one** example of a steroid hormone. *[1]*

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(ii) State **one** example of a hormone that is a tyrosine derivative. *[1]*

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(b) Outline the hormonal control of digestive juice secretion in the stomach. *[2]*

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(c) Outline how exercise causes an increase in the ventilation rate. *[3]*

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H3. Explain the mechanisms used by the ileum to absorb and transport food. *[6]*

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