Module Code: BIO00012C

Examination Candidate Number: ____________
Desk Number: ____________

BSc / MSc Degree Examinations 2018-9

Department:
Biology

Title of Exam:
Animal and plant biology Part II

Time Allowed:
2 hours

Allocation of Marks:
Total marks available for this paper: 60

Instructions for Candidates:
Any instructions for the students, e.g. ‘Answer any two questions’

Materials Supplied:
Click here to enter text if other materials are needed. Delete any unnecessary fields.

Do not write on this booklet before the exam begins
Do not turn over this page until instructed to do so by an invigilator
1. a) On the graph below, which line (A or B) represents an endothermic animal? Justify your answer. (3 marks)

Line A (1). This is because their body temperature is less affected by environmental temperature compared with an ectotherm (1) due to internal (metabolic) heat production (1).

Mostly answered well. Didn’t accept the justification “endotherms can thermoregulate” as ectotherms also have some mechanisms for thermoregulation.

b) In an endotherm, explain how oxygen consumption changes in cold environmental temperatures. (2 marks)

Oxygen consumption would increase in cold temperatures (1) because the animal would expend energy (and therefore oxygen) to generate heat (1).

Answered well. Some stated that oxygen consumption decreases due to torpor/ hibernation - this is incorrect as this is only in unusual cases, not in a typical endothermic animal. Some answers described a mechanism for generating heat (e.g. shivering) which I accepted.

c) Name one technique used to measure whole body oxygen consumption. (1 mark)

A number of answers possible including direct/ indirect calorimetry and
Also accepted respirometry. Some answers stated a technique such as measuring respiratory quotient - this was not accepted as you needed to state the name of the technique for measuring this.

2.  
   a) In animals with a closed circulatory system, what are the 2 types of extracellular fluid and what are the main differences between these 2 fluid types? (2 marks)

   Blood and interstitial fluid (1) - both needed for the mark. The main difference is that blood contains proteins and blood cells (1).

   b) What vessel type experiences the highest blood velocity and how is the structure of this vessel type adapted to withstand this blood flow? (3 marks)

   Arteries (1). They have thick walls (1) especially due to increased elastin in the tunica media (1)

   This question was answered well with most answers attracting some (if not full) marks. Did not accept the aorta as the vessel with the highest velocity as this is not a vessel ‘type’.

3.  
   What is the preferred form of stored energy and where in the body is this located? (2 marks)

   Triglycerides (1) (will not accept lipids) stored in adipose tissue (1).

   Many answers stated glycogen as the answer here. Although glucose is the preferred energy source for many tissues, this question specifically asked for the preferred form of stored energy, which is triglycerides.

4.  
   Explain the consequence of a gene mutation resulting in a non-functional anti-diuretic hormone receptor in mammals. (3 marks)

   If the receptor is non-functional, aquaporin channels would not be able to translocate to the membrane (1) in the collecting duct (1) and therefore there would be less water reabsorption/ more water loss (1).
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Most answers were awarded some marks for this question. Marks were lost for lack of detail e.g. not stating that ADH-mediated water reabsorption occurs in the collecting duct.

5. Researchers have been studying the interaction between Caribbean cleaning gobies (*Elacatinus evelynae*) and longfin damselfish (*Stegastes diencaeus*). The goby ‘cleaner’ fish remove and eat ectoparasites from their damselfish ‘clients’.

a) What type of interaction exists between these two fish species? (1 mark)

Mutualism/symbiosis/mutualistic or symbiotic relationship (1)

Most students answered this well.

The researchers found the nature of this interaction changes over time. The figure below shows how damselfish parasite load (pre-cleaning) varies over the course of four months and how this affects cleaner fish behaviour.

b) Interpret the figure above and comment on how the interaction between these two species changes over time? (3 marks)

Cleaner fish remove/eat more damselfish scales when their parasite load is
low/ there is a negative relationship between scale eating and parasite load (1)
Parasite load increases over the summer/ changes over time(1)

Cleaner fish cheat / the interaction becomes parasitic when parasite loads are low (1)

MLOs
- Review of the population dynamics of single and multi-species communities
- Perform simple experiments in Biology and to collect, analyse and present the results in an appropriate format.

6. Describe and explain the changing levels of luteinising hormone (LH) during the follicular phase of the human female menstrual cycle. (6 marks)

During the early stages of the follicular phase, oestrogen secreted by the follicles has an inhibitory effect on the production of LH (1), keeping LH levels low (1). As oestrogen secretion by the maturing follicles increases towards the end of the follicular phase (1), the high levels of oestrogen stimulate LH production (1), which in turn stimulates oestrogen production by the follicles (1). This positive feedback loop leads to a surge of LH at the end of the follicular phase (1).

Only very few answers were awarded full marks. Some answers described the changes in LH levels, but did not make it clear that oestrogen initially has a negative effect on LH, which changes to a positive feedback loop towards the end of the follicular phase. Some students described the events in the luteal rather than the follicular phase, and several students did not attempt to answer the question. Many answers were not awarded any marks.

7a) An ecologist studies the terrestrial habitats of a group of four oceanic islands in the Hawaiian archipelago. They generate a table detailing the presence/absence of three different types of crab species across marsh, beach, and grassland habitats.
Using your understanding of niches and competition, describe (1 mark) and explain the distribution of crab species #2 across the habitats (3 marks).

<table>
<thead>
<tr>
<th>Island</th>
<th>Marsh</th>
<th>Sandy beach</th>
<th>Grassland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Island A</td>
<td>Crab sp3</td>
<td>Crab sp2</td>
<td>Crab sp1</td>
</tr>
<tr>
<td>Island B</td>
<td>Crab sp3</td>
<td>Crab sp2</td>
<td>Crab sp3</td>
</tr>
<tr>
<td>Island C</td>
<td>Crab sp1</td>
<td>Crab sp2</td>
<td>Crab sp1</td>
</tr>
<tr>
<td>Island D</td>
<td>Crab sp2</td>
<td>Crab sp2</td>
<td>Crab sp2</td>
</tr>
</tbody>
</table>

Data from Island D demonstrate that crab sp #2 can expand into all 3 habitat types. When sp#1 and sp#3 are present crab sp #2 is outcompeted and its distribution is restricted to sandy beaches (1 mark).

This dataset highlights an example of competitive release (1 mark). The species distribution of crab sp #2 is limited by inter-specific competition. The data helps demonstrate the difference between the fundamental niche of crab sp #2 (evident when no competitors present) versus its realised niche, which is narrower and is defined as the set of conditions/resources that is actually occupied (2 marks).

Most students gained some marks in this question, though a large number did not fully understand the concept that competitive exclusion was acting on species #2. A number of students described species 2 as outcompeting species #1 and #3 on sandy beaches. The data provided do not suggest that sandy beaches are part of the fundamental niche for either species #1 or #3, for example there is no island E showing that species #1 occupies all 3 habitats in the absence of crab species #2.

b) The ecologist goes to Island D and constructs a life table for crab species #2. What assumption would they have to make about changes in population size on the island for this species (1 mark)?

They would have to assume that changes in population size for the species are due only to changes in birth & death rates, i.e. it is a closed population with no migration (immigration/emigration) (1 mark).

Mainly answered well. Some students confused this with competition though most understood this was considering the limitations of life tables in assuming
that populations are closed.

c) From this life table they calculate $R_0$ (the basic reproductive rate) for the population of crab sp #2 on Island D, which is 1.78. What does this tell us about the size of the crab population (1 mark)?

As the value of $R_0$ is greater than 1, the population is increasing in size over time (1 mark).

Answered well, with most students able to interpret the reproductive rate in the context of population size.

d) A team of ecologists expands the study. They survey the biodiversity of all fauna on each of the islands, including Hawaii’s Big Island. They discover that Hawaii’s Big Island has the greatest biodiversity, and that Island D has a lower species richness than Island A. Suggest why species richness is lower on Island D (1 mark).

As distance (island isolation) from Hawaii’s Big Island increases, species richness decreases. More isolated islands have lower immigration (colonization) rates than islands closer to mainland areas (Big Island) (1 mark).

OR Island A has a larger area than Island D and so can support more species. Larger islands receive more colonists than smaller islands and can support more species than smaller islands (e.g. increased resources, habitats) / the extinction rate is lower (1 mark).

MLO 9: Review of the population dynamics of single and multi-species communities.
MLO10: Describe the simple emergent patterns in community structure and their causes.
MLO 13: Explain the theory of Island Biogeography and why small isolated islands support fewer species.

Most students answered this well. Marks were awarded for the description of concepts that did not necessarily contain specific relevant terminology, though this is an area in which students could look to improve in future. Overall there was a good understanding of the concepts around island biogeography.

8 a) Name three pools within the global carbon cycle in which carbon is currently accumulating. (3 marks)

i)  
ii)  
iii)  

3 from Atmosphere, soils, forests/vegetation, oceans.

b) Sketch a diagram showing how ecological communities play a role in the global carbon cycle. (4 marks)

Marking guidelines:
Key elements: respiration/photosynthesis (1), and microbial respiration and decomposition (1), with terrestrial and marine communities referenced (1) and clear indication of how these slot into the larger picture (1). Marks given for sensible answers. Examples of diagrams seen in lectures given below.
MLO Review of the population dynamics of single and multi-species communities.
MLO Describe the simple emergent patterns in community structure and their causes.
MLO Describe the principles of element cycles.

9. List a) two predictions (1 mark) and b) four assumptions (2 marks) of the Ideal Free Distribution (IFD) model

a)

b)

Answer:
a) Animals have the same rate of food intake and numbers are proportional to patch richness (1 mark).
b) Any four of: Animals are equal competitors; they have perfect knowledge of food and competitors; they can move without cost or constraint; they try to maximize rate of food intake; the system is a closed one. 1 mark for each pair.

Feedback: part a) tended to be the worst answered, and several people mistook predictions for assumptions and vis-versa. A common mistake was to write species richness instead
of number of individuals. Most people got at least one mark on part b), and a common
mistakes included saying that there was no competition.

c) There are twenty-seven fish in a tank. Food is delivered at five pellets per minute at the
north end of the tank and ten pellets per minute at the south end. What is your prediction of
the number of fish at each end, if the fish follow the IFD? Show your working (2 marks)

Answer: North end food = 5/15 = 1/3. 27/3 = 9 fish South = 10/15 = 2/3. (27x2)/3 = 18 fish. 1 mark
for each correct answer correctly and clearly worked.

Learning outcome addressed: Explain how animal behaviour can be studied.

Feedback: the best answered part of this question, with most people scoring full marks. In most
cases the working was not very transparent but I was liberal.

10. A researcher observes that earthworms sometimes come out of their burrows and drag
leaves down into them to eat. The researcher speculates that this behaviour might follow a
biological rhythm of a particular periodicity.
a) Name two types of biological rhythm that could describe the earthworm foraging
behaviour (1 mark)

Answer: Good answers might include circadian, infradian, and circannual. Ultradian and
infraannual are less likely. Two correct answers needed for the mark.

Feedback: I was surprised how few people went for both circadian and circannual, which
was the easiest combination to both remember and make work here. I generally needed the
names to be correct. Ultradian can't work very well and I did not award marks for that.

b) The researcher decides to measure how much an earthworm does this activity over time.
What periodicity would be predicted for each of the rhythms you suggested in a)? (1 mark)

Answer: e.g. circadian a 24 hour period; circannual a year-long period. Both need to be
correct for the mark.

Feedback: I noted when errors were carried forward here and did not penalize twice. If you
got the right definition, I gave the mark, as long as the context was correct. A common
mistake was to mix up the meaning of infradian and ultradian.

c) Suggest a ‘Zeitgeber’ for each rhythm (1 mark)

Answer: e.g. light for circadian, daylength for circannual; both need to be sensible and
correct for the mark.
Feedback: the worst answered part of this question, with most people not remembering what it meant. There were some suggestions which stretched credibility and which didn’t generally get marks.

d) Suggest a functional explanation for both these rhythms (2 marks)

Answer: e.g. feeding only at night reduces predation risk; feeding mostly in winter increases food availability. 1 mark for each sensible answer.

Feedback: Generally good answers if circadian and circannual were the suggested rhythms. For other rhythms it was harder to make viable suggestions and they generally didn’t get marks. A common answer which didn’t get marks was that the animal was hungry, which is just another way of saying it was motivated to feed and is not a functional explanation.

Learning outcome addressed: Explain how animal behaviour can be studied.

11. In the lakes of New Zealand, a trematode worm, Microphallus, parasitizes the snail Potamopyrgus antipodarum, castrating males and sterilizing female hosts. The parasite has a much shorter generation time than the host.

   Populations of snails and parasites were collected from each of three different lakes. In a laboratory experiment much higher rates of infection were found when parasites were put together with snails collected from same lake.

   a) Provide an explanation for this observation. (2 marks)

   The parasites had adapted to overcome the defences of the snails found in their home lake.

   Closer inspection of snail populations in each of the three lakes indicated that the most abundant genotype varied from one year to the next. Roughly a year after a snail genotype was the most abundant, it was found to be one of the least abundant in the population.

   b) Suggest an explanation for this observation. (2 marks)

   Parasite populations are able to evolve rapidly to exploit the snail genotypes in their local environment.
A laboratory experiment examined the infection rates of each snail genotype from the same lake. The average infection rate in the four most common genotypes was 90%, but the average infection rate for the 40 rarest genotypes was less than 50%.

c) What do you conclude from this experiment? (3 marks)

It is likely that the snail genotypes vary from year to year because common genotypes are attacked more successfully by many parasites, placing them at a disadvantage and driving down their numbers (1 mark). The rarer genotypes are not attacked by as many parasites giving these snails an advantage over the common genotypes (1 mark). Snail genotypes with the lowest infection rates are more likely to be common the following year (1 mark).

d) In another lake at a different location it was found that there were very few snails present. What evidence could be collected to support efforts to maintain the snail population in this lake? (3 marks)

Investigate whether a range of organisms infected by *Microphallus* to gain a better understanding of the web of interactions of this host/parasite (1 mark) and host with either strong dilution, buffering or amplifying effects on the parasite (1 mark). Investigate the influence of the changes to environment, or climate, that might affect host/parasite interactions (1 mark).

This was a synoptic question that was answer well overall. Although you had not heard about this example before you would have had examples of relevant experiments throughout the module. Many students achieved at least four marks on part a and part b and demonstrated that they understood the information provided to them. Fewer students answered part c as well, probably because this tested a higher level of understanding. Even fewer students answered part d well and this is likely due to having to draw on knowledge and understanding about the wider context of the research described in this question.