Module Code: BIO00053I

Examination Candidate Number: __________
Desk Number: __________

BSc Degree Examinations 2018-9

Department: BIOLOGY

Title of Exam: Ecology of Animals, Plants and Microbes

Time Allowed: 1.5 hours

Marking Scheme: Total marks available for this paper: 60
The marks available for each question are indicated on the paper

Instructions: Answer all questions in the spaces provided on the examination paper

Materials Supplied: Calculator

For marker use only:
Office use only:

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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 scientist wishes to investigate how competition impacts plant root foraging. They grow two plants of the same species with their roots split evenly between two pots (see experimental plants). As a control they grow two plants, again of the same species, but this time each contained within an individual pot as illustrated by the figure below. All pots are identical in dimensions and nutrient concentration. The experiment is replicated appropriately.

At the end of the experimental period they record the mean biomass of the experimental and control plants and find the experimental plants have produced more root biomass but less reproductive biomass than the controls.

a. The student determined the root weight ratio (RWR) for the experimental and control plants. How is the RWR determined and deduce if the experimental or the control plants would have a higher RWR.  

(2 marks)

The space above the line is sufficient for your answer.
b. Give two reasons why determining root biomass might not be the most appropriate measure of the stated aim of measuring root foraging ability and suggest two other root traits that might be more appropriate in order to address this aim. (4 marks)

c. Comment on the choice of control in the study and explain how this may have impacted the results obtained. (3 marks)

d. Draw and label a graph that shows roots with a half-life of 30 days and explain the shape of the line drawn in relation to root function. (6 marks)
2. For the game below: i) find all the pure Nash equilibria; ii) indicate which, if any, are pure evolutionary stable strategies and state why. (3 marks)

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<tr>
<td>A</td>
<td>0, 0</td>
<td>2, 1</td>
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<tr>
<td>B</td>
<td>1, 2</td>
<td>0, 0</td>
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3. Complete the matrix below with numeric payoffs that would make A and B both ESSs in the game. (2 marks)

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4. In a population of animals, any two animals of the same species will randomly pair up and simultaneously approach a difficult-to-access resource multiple times in their lifetime. When the resource is accessed, it confers a benefit $b$ to each animal, regardless of who accessed it, but there’s also a cost $c$ to an animal that accesses it alone. If both animals work together to access it simultaneously, they split the cost equally.

a. Sketch the payoff matrix for this game (3 marks)
b. In terms of $b$ and $c$, what is the evolutionarily stable proportion for the mixed strategy of accessing the resource? (7 marks)

5. The Superb Starling *Lamprotornis superbus* is socially monogamous and rears young with help from its mate and from the previous year’s adult offspring. Superb starlings live in social groups; genetic analysis of parentage of fledglings showed extra-pair matings occurred both within and outside the social group.

a. Females rearing extra-pair young sired by males from within the social group typically had 2-3 surviving offspring from the previous year, whereas females rearing only young sired by their mate had 0-1 surviving offspring. What do these data suggest about the benefits of extra-pair mating within the social group for the females? (2 marks)
b. What does this graph tell us about the benefits of extra pair mating outside of the social group for the female starlings?  

![Graph showing standardized heterozygosity comparison]

(2 marks)

c. Adult offspring who helped at the nest suffered a loss in body mass twice that of their parents. Give examples of one direct benefit and one indirect benefit that could offset this costly helping behaviour.  

(3 marks)
6. 
   a. Chickens have specific alarm calls for aerial and ground predators. Explain why they make aerial predator alarm calls only when a conspecific is present, but make ground predator alarm calls even in the absence of a conspecific.  
      (2 marks)

   b. Where would we predict the most dominant chicken to be located within the group under threat of i) aerial and ii) ground predation. Explain why.  
      (2 marks)

   c. Over 60% of alarm calls made by chickens are false alarms. Why do chickens continue to respond to such unreliable signallers?  
      (1 mark)
d. Draw the predicted benefit of the dilution effect onto the below graph. What do the data on this graph tell us about the mechanisms through which grouping protects chickens from aerial attack? (3 marks)
7.

a. Using a pseudo-math equation, describe how plant biomass changes for a tree species over time. Incorporate individual species growth and the effects of competition and identify environmental and biological parameters that are important to understand the outcome of individual processes:  

(7 marks)

The space above the line is sufficient for your answer.
b. Generate a flow diagram that represents a single plant’s growth over a daily cycle (not considering competition). The flow chart should be applicable at any time of the year and should include an output option. (6 marks)
c. Using the graph chart below, describe the output from the model code. **(2 marks)**

```
for (dy in 1:365){
    if (dy >= 1 AND dy < 60)
        sfall = 1
    else if (dy >= 61 AND dy < 300)
        sfall = 0
    else {
        (dy >= 301 AND dy <= 365)
        sfall = 1
    }
    print(paste(sfall))
    plot(sfall)
}
next
```