Note on grading: Each of the 10 questions is worth 5%, and the Netlogo part is worth 50%.

1. Consider the discussion of ant-colony task allocation in the book and in the Deborah Gordon video we saw in class. Explain in a paragraph, in your own words, how ants decide when to switch tasks, and how they decide what task to perform.

2. Watch the TED talk by Bonnie Bassler at [http://www.ted.com/talks/lang/eng/bonnie_bassler_on_how_bacteria_communicate.html](http://www.ted.com/talks/lang/eng/bonnie_bassler_on_how_bacteria_communicate.html). Then describe in a paragraph how bacteria “communicate via sampling”?

3. In chapter 12, p. 180, the book says that in ant colonies, the immune system, and related distributed living systems, “information must be communicated via spatial and temporal sampling”. In a paragraph or two, give examples (from what you have read and from the videos you have seen) of what spatial and temporal patterns are being sampled and what information such sampling conveys in (a) ant colonies; (b) the immune system; and (c) bacterial colonies.

4. Using the discussion in Chapter 12 of the book and any additional knowledge you have of ants, describe two different ways in which randomness plays an adaptive role in ant colonies.

5. Answer the same question as in (4), but for the immune system.

6. Discuss (in one or two paragraphs) four major differences between computation in traditional von-Neumann-style computers and computation in living systems.

7. Suppose two players, A and B, play an iterated Prisoner's Dilemma (that is, play $N$ repeated games against each other), using the payoff matrix given on p. 215 of the textbook.

   (a) Suppose player A's strategy is `always defect" and player B's strategy is `always defect". What will each player's average score be at the end of the $N$ games?

   (b) Suppose player A's strategy is `always cooperate" and player B's strategy is `always cooperate". What will each player's average score be at the end of the $N$ games?

   (c) Suppose player A's strategy is `always defect" and player B's strategy is `always cooperate". What will each player's average score be at the end of the $N$ games?
8. Explain, in your own words (in a paragraph) what the "paradox" of the Prisoner's Dilemma is, as discussed in Chapter 14, p. 214. Describe a real-life example of this paradox.

9. As described in Chapter 14, Axelrod proposed that the characteristics needed for a successful iterated Prisoner's Dilemma strategy are to be "nice, retaliatory, forgiving, and clear". Explain (in one paragraph) why the TIT FOR TAT strategy has these four characteristics.

10. From your own experience, give an example of a "Social Norm" and an example of a "Meta-norm", analogous to those discussed in Chapter 14. Do you think that the norm and / or meta-norm from your example have been effective in producing the desired social behavior?

Netlogo part:

In this part you will experiment with various strategies for playing the Prisoner's Dilemma, and with different variations on the Prisoner's Dilemma game. You will be using the Netlogo "PD Two Person Iterated" model, which can be accessed via the File menu, under Models Library -> Social Science -> (unverified) -> Prisoner's Dilemma -> PD Two Person Iterated.

(a) The Netlogo model lets you experiment with six different strategies: (a) "random", (b) "cooperate", (c) "defect", (d) "tit-for-tat", (e) "tit-for-two-tats", and (f) "unforgiving". Briefly explain how each of these strategies work.

(b) Set the computer-strategy to "random" (i.e., randomly cooperate or defect). What are the approximate average scores of the human and the computer when the human-strategy is set to each of the six possible strategies? (Record the approximate average score for each after about 300 iterations.) Which is the overall best strategy for the human when the computer has strategy "random"? Why do you think this one gets the best results?

(c). Propose a new strategy, different from the six listed above. Describe it in your report. Under the Procedures tab, modify the function "to custom-strategy" to implement your new strategy. Assign this custom strategy to the human, and test it against the computer playing each of the six other strategies (for each computer strategy, record the approximate average score for the human and the computer after about 300 iterations). Discuss why your custom strategy produced the results you got.

(d). Propose a modified payoff matrix, different from the one given in the textbook, p. 14.3, and describe it in your report. Under the Procedures tab, implement your modified payoff matrix by changing the numbers in the "to get-payoff" function. Repeat step (2) with this new payoff matrix, recording the approximate average scores of human and computer after about 300 iterations. Discuss if, how, and why your modified payoff matrix changed the results from those you obtained in step (2).