BISC 204 Final Paper Guidelines

General Information

The goal of the final paper (and our activities in the final three lab meetings of our course) is to use the tools that we've learned in class in developing, describing, coding, running, analyzing, and interpreting models, to your own systems. The final paper is the last assessment for the class, is **due by 4pm on May 22 via Sakai**, and is worth 100 points toward your final grade (out of 500 total points). Your paper must be **no more than 6 single-spaced pages** at 12-point font, **including figures and tables but excluding references**, and you are strongly encouraged to be succinct and direct in your presentation for clarity and brevity.

Final Paper Topic

For the final paper, you will choose a model that we haven't explored deeply in class (*i.e.*, one that wasn't the topic of a lab report). This can be any model composed of differential equations that you'd like. I compiled an initial list of suggested topic areas on the "Potential Ideas" handout. This includes many examples of models that are touched on in the *Modeling Life* book, but either weren't described in great detail, or we didn't have time to investigate deeply in class and lab. It also includes some other resources for models (particularly for ecology models). If you have a different model that you're really interested in and it fits the guidelines of the final paper, you may use your own example that is outside this set of examples after consulting with me during lab on April 19 about your ideas. The model that you choose should be a system of differential equations like the ones we've been working with in class this semester.

The topic of your final paper will use this model that you choose to run a modeling experiment (or set of experiments) that directly informs a research question or tests a hypothesis. The modeling experiments should be grounded in a question/mechanism that is biologically interesting (*i.e.*, you should be able to clearly motivate why changing the model in some way is relevant to biological outcomes) and can be conducted by changing parameter(s) values, parameter constructions (linear or nonlinear feedbacks), or adding/removing terms/processes from the differential equations.

Once you have decided on a system and model and have planned a set of modeling experiments, you will code the model in R and perform the modeling experiments. We'll devote the last three lab sections of the course to working on the final paper projects, so that you'll have plenty of time for exploration and feedback.

Final Paper Structure

Your final paper must have the following nine sections: Title, Abstract, Introduction, Model Description, Experimental Methods, Results, Discussion & Conclusions, and References, with R code submitted as a separate file. Throughout the text (usually in the introduction and discussion there are natural opportunities to do this) you must cite at least three references from the primary scientific literature and include the full citations in the References section at the end. Each section should be organized as:

1. **Title** (5 points)
    i. Informative and brief description that highlights your system and research question/hypothesis results
2. **Abstract** (5 points)
    i. In fewer than 300 words, describe the motivation for your study, what you did, and the main conclusions of your analysis.
3. **Introduction** (15 points, 5 points each sub-section)
    i. Present a brief introduction to your system that includes how your system fits into the larger scheme of biology
    ii. Motivate your research question or hypothesis that you investigated (i.e., why is your system and question important).
    iii. Clearly state your research question or hypothesis.
4. **Model Description** (15 points, 5 points each sub-section)
    i. Provide a graphic (conceptual figure, box and arrows diagram) that outlines the dynamics within your system.
    ii. Describe (in text) how your system works, and define all variables and parameters within your model.
    iii. Describe at least five assumptions within your model, being sure to include any that are closely relevant to the interpretation of your model for other biologists in this sub-field.
5. **Experimental Methods** (15 points, 5 points each sub-section)
    i. Describe the set of modeling simulations that you ran to investigate your key research question or test your hypothesis. Be sure to describe how the modeling experiment connects to changes in model version, parameter values, etc. in your explanation, and how this ties back to your research question or hypothesis.
    ii. If you are running different versions of a model, emphasize the similarities and differences among the models in your experiments.
    iii. Provide a table(s) that contains the parameter values, initial conditions, and any other things that changed for your modeling experiment.

6. **Results** (15 points, 5 points each sub-section)
    i. Include at least two figures that highlight how your modeling experiment addressed your research question or hypothesis. Include a caption with the figure number beneath each figure (number them in the order that they are discussed in the text of the Results section) and provide a sentence or two in the caption summarizing the figure.
    ii. Describe the results from your modeling experiment outlined in the Experimental Methods section. Focus on the description (the "what" of the results) of the model output. Refer to figures and/or tables as appropriate in your descriptions.
    iii. Be sure to focus on results that directly link back to your research question or hypothesis, and structure your results into a logical order that parallels the order of your question/hypothesis.
7. **Discussion & Conclusions** (15 points, 5 points each sub-section)
    i. In text, discuss the "how" and "why" that connects your results back to your research question or hypothesis. Discuss how your experiments informed your research question or hypothesis.
    ii. Describe any nuances or complexities in the interpretation of your analysis – did you have any results that were surprising or didn't clearly inform your question or hypothesis? Any processes that might complicate/limit the extrapolation of your results?
    iii. Describe next steps for this line of scientific inquiry: if you were going to do a set of modeling experiments again, what would you change? How could these results help to inform future experiments? What did this analysis tell us about this biological system?
8. **R code** (15 points, 5 points each sub-section)
    i. Clearly document and comment the R code needed to fully reproduce the analysis in your methods and results sections.
    ii. In the final version, be sure to only include the code that is needed to support your paper, not preliminary investigations or exploratory figures.
    iii. Organize your code by the figures presented, with comments that indicate which figures were produced by which code.