The Senior Exercise in BIOLOGY and MOLECULAR BIOLOGY
2003-2004

The goals of the Senior Exercise are:

- to demonstrate facility in the use of primary literature as the foundation for understanding and developing ideas and arguments.
- to demonstrate facility in understanding and thinking critically about experimental design and data.
- to demonstrate facility in identifying important questions and designing new experiments.
- to demonstrate facility in integrating material from several courses or subdisciplines.
- to demonstrate retention of basic biological information.

The Senior Exercise has three required components that are described in more detail below:

- Attending 4 Departmental Seminars
- Writing an essay composed of three parts; and
- Taking an Educational Testing Service Subject Exam in late January-early February to aid in the assessment of our programs.

Attending Departmental Seminars

Each semester the Department sponsors five or six seminars. These seminars, usually by outside speakers, expose students to methods and thinking used in biology. Attending these seminars promotes all of the goals of the Senior Exercise.

You are required during the senior year to attend four of the seminars as part of the senior exercise. You should aim to complete this during the first semester of the senior year, but it must be completed no later than February 26, 2004. Do not make the assumption that all seminars will be given as scheduled, as illness and bad weather can result in cancellations. Try to get to the seminars earlier in the year if possible, as the winter seminars sometimes result in cancellations. It is your responsibility to sign the attendance list for each seminar you attend and only seminars for which you have signed in can be counted towards the requirement.

The Essays

The written portion of your senior exercise will involve a three-part essay that critiques and builds on a published journal article. In the first part you will describe and evaluate the experimental design and data presented in the article. In the second part you will discuss how the results presented in the article relate to the other sub-disciplines of biology that you have studied in your coursework while at Kenyon, as well as the overall significance of the work. In
the third part you will describe future work that needs to be done to address important questions that arise from the article.

Advice:
• Effective language use will be critical to your success. The 1000-word limit for each part, with a 3000-word limit total, puts your prose on a tight budget. Organize each essay by preparing an effective outline; ideas and paragraphs should flow logically. Avoid wordiness, and use care with sentence structure. Don't obscure your meaning with multiple clauses and overly complicated constructions.

Choosing a Faculty Mentor

The first step will be to choose a faculty mentor who will advise you on the written portion of the senior exercise. You should select a faculty mentor whose field of expertise or interest is reasonably related to the area you expect to research.

Note: Generally, faculty can only accept 4 seniors and these include all senior Honors students working in their labs.

You may choose your faculty mentor at the end of the spring semester of your Junior year before you leave for summer vacation. You must do it no later than Sept. 1, 2003.

• Have the attached Senior Exercise Faculty Mentor Form signed by your selected mentor and return it to the Department Office.
• Place your name on the Master List in Bio Room 212, identifying students with mentors. You must have written approval from the faculty member on the form before signing the Master List.

Choosing a Journal Article

You will begin by choosing a recent research study that will lend itself to the type of analysis required in the essay. The article must have been published in a well-respected journal (see suggestions below) within the last five years. Be sure that you select a journal article that interests you - you will need to do additional background reading of primary and secondary sources in order to complete the essays. Try to select a paper that makes an important or controversial contribution to the field, as it is hard to write an interesting analysis of a boring or insubstantial paper. When choosing an article, be sure that you will be able to use it to address each of the essay topics described in more detail below.

You will need to submit three possible journal articles for approval, in order to make certain that the article you choose is appropriate before you begin writing your essays. In consultation with your faculty mentor, one article will be selected from those submitted. You are encouraged to work with your faculty mentor prior to the deadline to identify appropriate journals or journals articles. For your guidance, a list of well-respected journals is provided below. Note that this list is not exhaustive, and that you are not limited to the journals suggested here.
Suggested Journals:

Animal Behavior
Am. J. Physiol.
American Naturalist
Behavioral Ecology
Biophysical J.
Cell (and other Cell journals)
Development
Developmental Biology
Ecological Applications
Ecology
EMBO
Evolution
Genes and Development
Genetics
J. Bacteriology
J. Biological Chemistry
J. Cell Biology
J. Virology
Molecular and Cellular Biology
Molecular Microbiology
Nature
Oecologica
Plant Cell
Plant Cell and Environment
Plant Journal
Plant Physiology
Planta
Science
Virology

Annotated Bibliography

The purpose of the annotated bibliography is to demonstrate your ability to identify additional sources related to your journal article that you are likely to use in writing your essay.

Provide all necessary citation information for all references. 10 - 15 references should be from the primary literature, i.e., peer-reviewed scientific journal articles, and up to 5 references can be from the review literature. Use the citation style shown below, and follow the citation with a short (2 or 3 sentence) description about the paper. In your annotation be sure to address why this paper will be useful to you as you write your essays.

Example:

The authors present an analysis of demographic factors that contribute to the 10 year population cycle of the snowshoe hare. Experimental evidence is provided on both the direct (mortality) and indirect (reduced birthrates) consequences of predation. Hypotheses to explain the synchrony in hare cycles across broad geographic areas are also presented. This will help support my argument that predation is the primary cause of demographic change in hare populations.

Part 1: Critical Analysis  (1000 words)

The purpose of the first essay is to demonstrate your ability to understand and think critically about both experimental design and data. Your overall objective is to describe and evaluate the primary experiments and analyze the results.
Experimental Design. A well done essay will reflect a thorough understanding of the overall objective and specific experimental aims of the paper. The essay should clearly define the model system and techniques employed, as well as the relative strengths and weaknesses of other approaches to the same question. Are the model system and experimental design(s) appropriate? Why or why not?

Data and Interpretation. Center your data analysis on the two or three most important figures or tables. These should be prepared as a part of your document and attached to the back (N.B., figures/legends or tables/captions do not count against the 1000-word limit). Specific references to particular features of the figures or tables are entirely appropriate.

Strong essays will identify and discuss both the strengths and shortcomings of the data in individual experiments. An understanding of the logical framework of the paper will also be evident. How do the results of each experiment lead to the overall conclusion? To what degree do the data support the authors' claims? Are there particularly clever or innovative strategies for resolving uncertainties? Discuss alternative interpretations, experiment designs, or relevant controls that would refine or improve the conclusions of the paper.

Advice:
• Don't confuse a critical analysis with a summary. Put yourself in the place of a reviewer evaluating a manuscript for publication. This approach requires not only careful thinking but also a certain level of overall expertise. To write an effective critical analysis, you will likely need to familiarize yourself with the field by consulting other relevant papers. Reading beyond your primary paper will also contribute to your efforts on the remaining two parts of your essay.

Part 2: The biological context (1000 words)

The purpose of the second part is to demonstrate your ability to place your paper in the context of what you know about biological systems. In doing so you will focus on two primary questions: how does your paper relate to the sub-disciplines of biology that you have studied in your coursework while at Kenyon, and what is the overall significance of the work?

In composing this essay, draw upon what you have learned in the biology courses that you have taken. Successful essays will use this understanding to demonstrate how your paper relates to the field of biology. In your analysis pay special attention to the different levels of biological organization. What insights can you glean from the paper when thinking about larger or smaller levels of biological organization? In light of this, why are the results of this paper significant?

Advice:
• This part will require both critical thinking about what biology is, as well as a certain level of expertise in the field. This in turn will require revisiting class notes and/or texts, as well as some key literature that relates to your paper. Be sure to reference the relevant texts or literature used in your synthesis.
• Your essay must span several levels of biological knowledge. For example, if the main focus of your journal article is population biology, you should aim to relate it to landscape, organismal, cellular and molecular biology. If the main focus of your journal article is
cellular biology, you should aim to relate it to landscape, populational, organismal, and molecular biology. In addition, your essay should explicitly make links and connections among different biological levels and approaches towards understanding biology.

**Part 3: Future Work** (1000 words)

The purpose of the third part is to demonstrate your ability to identify important questions and to design experiments. Your overall objective is to describe the future work that needs to be done to address the next important questions that arise from your article.

You should describe at least three distinct experiments in your 1000 word essay. You may describe experiments that extend or confirm the findings of your article. You may also describe other approaches to explore the fundamental research questions in your article. Finally, you may propose new research questions in the same specific field and describe how they might be investigated.

You must describe your proposed future work in detail. Present a research question and a hypothesis. Describe the experimental system and the specific techniques and methods that will be used to test the hypothesis. Where appropriate, describe the control groups and the data analysis that will be employed. State what results would support or contradict the hypothesis. Indicate potential problems that might arise during the experiments and suggest alternate strategies where possible.

**Advice:**
- You may not describe experiments that have already been published as your future work, and it is your responsibility to know the literature well enough to avoid previously published experiments. Where possible you should reference relevant literature to support your proposed research questions and experiments.

**Due Dates and Mechanics**

All submissions are made to Ms. Busenburg in the Biology Office by 12 noon on due date.

- **Sept. 1** Final date for commitment to mentor. Faculty mentor form returned to Department Office & sign-up on Master List in Biology Office.
- **Sept. 15** Submission of three journal articles for consideration by your faculty mentor.
- **Oct. 6** Annotated bibliography
- **Oct. 20** Complete manuscript version of essay along with journal article.
- **Nov. 10** Revised manuscript, in **paper** and **electronic form**, along with copies of most pertinent primary literature cited (5-10 primary sources).

**Due dates are non-negotiable.** If any deadline is not met, the Dean of Students will be notified, and you may be required to begin the written portion of the senior exercise over with a new journal article. Comments by your faculty mentor will generally be returned within one week following each deadline.
All drafts submitted must show professional English style and usage throughout. If deficiencies appear, you will be required to work with a scientifically literate tutor at the Writing Center or your faculty mentor before submitting the revised manuscript. Revised manuscripts that still show serious deficiencies in style will not satisfy the senior exercise. Essays receiving Distinction are usually marked by originality and outstanding scientific writing, critical analysis, organization and flow of discussion, and use of primary literature.

Plagiarism: Please remember to write in your own words. Avoid close paraphrasing. Ask your mentor about paraphrasing if in question particularly regarding methods, introductory comments from research papers, and discussion comments. Always use quotes when using others words closely, but in science it is best to avoid quotes and describe things as you understand them. The electronic version of your essays will allow the faculty to easily check for plagiarism.

Your faculty mentor will assign a second reader. Each Senior Exercise will be read by at least two faculty and the department will approve the final evaluation.

You will be notified by the Department Chair by e-mail and/or letter of the decision of the Department regarding satisfactory completion of the essays. Decisions will be made by the end of the first semester. Should you not pass the written portion of the senior exercise you can attempt the exercise again in the second semester, according to a schedule arranged by the Chair and your mentor. Should you not satisfactorily complete any component of the senior exercise in biology YOU CANNOT GRADUATE.

Citations and References

Citations of References within the Text:
Footnotes are not used for citation in scientific papers.

Appropriate credit must be given to the author(s) of any reference material you use in your paper (and notebook writings) whether you quote the information directly or give it in your own words. Citations are given in the body of the text in parentheses. The surname(s) of the author(s) and the date of the reference should be given as illustrated in the following examples.

Please do not use numerals to designate the references; although this is done in some review or short articles, it makes reading the paper more difficult.

Indirect citations: name(s) and date are in parentheses

E.g. Although intracellular digestion has been recognized in brachiopods (Yonge, 1931) the possibility of the lophophore acting as a major site of intracellular digestion has only recently been suggested (McCammon and Reynolds, 1976).
Direct citations: name(s) are in text and date is in parentheses
e.g. Haber and Luippold (1960) studied the effects of gibberellin on the growth of wheat seedlings in which cell division was completely suppressed . . .

If a reference has two authors, give both names as in the second citation in the first example. When there are more than two authors for a reference, all the names need not be listed. The first author is listed and the term et al. ("and others" in Latin) is used to indicate that there are also other authors. "et al." should either be in italics or underlined.

e.g. Tiffon et al. (1974) reviewed intracellular digestion in lower metazoans....

Use of a secondary source: both original author and the author of the source used must be cited.
e.g. Daniel (1968, cited in Jones, 1977) found . . .

In this case, you must cite both Daniel (1968) and Jones (1977) in the References Cited section.

Direct quotations:
Do not use direct quotations or paraphrasing in scientific papers. You should describe the work of others in your own words and cite the work properly in text and in listed references. Relying on close paraphrasing of other’s work does not constitute “in your own words”. Should you choose to paraphrase, any close paraphrasing must be placed in quotes with square brackets showing those words you have added or altered (as per English standards).

REFERENCES CITED
This final section is an alphabetical (by author) list of the references cited in your paper. Include only those specific references cited in the text.

Journal article:
Name(s) of author(s). Date. Title of article. Title of journal (may be appropriately abbreviated) Vol. #: pages.

Example:

A book in which each chapter is an article written by a different author(s):
Name(s) of author(s). date. title of article. In title of book, editor(s). publisher, location of publisher, pages.

You may underline titles rather than using italics if you prefer.

Example:

A book with one author (or group of authors):
Name(s) of author(s). date. title of book. publisher, location of publisher, # of pages in the entire book.

Example:
Biology/Molecular Biology Senior Exercise Faculty Mentor Form

I have spoken with _______________________________ and agree to serve as her/his (student) faculty mentor for the written portion of his/her Senior Exercise.

Signed _______________________________
(faculty mentor)

Date: ______________________________

This agreement is due in the Department Office on September 1, 2003.