

The Senior Exercise in BIOLOGY and MOLECULAR BIOLOGY 2012-2013

In completing the Senior Exercise, students should:

- use primary literature as the foundation for understanding and developing ideas and arguments.
- understand and think critically about experimental design and data.
- identify important questions and design new experiments.
- integrate material from several courses or subdisciplines.
- consolidate and synthesize basic biological information.

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

- Attending 4 Departmental Seminars
 - Taking an Educational Testing Service Subject Exam in late January-early February; and
 - Writing an essay composed of three parts.
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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 the end of **February, 2013**. 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. Students who have conflicts with meeting the required seminar attendance because of participation in intercollegiate athletics should contact the Chair of Biology.

ETS Subject Exam

The Educational Testing Service Subject Exam is typically held on a Saturday morning in early February. This exam is designed to test your cumulative knowledge in the field of Biology, and serves the Biology department as a useful assessment of both individual students and our overall programs. We do not ask you to study for this exam, as we are interested in finding out what you know overall. However, you do need to take the exam seriously, as it is a graduation requirement. Scores will be sent to you after spring break.

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 2- 3 seniors, and these include all senior Honors students working in their labs.

You may choose your faculty mentor during the last two weeks of classes at the end of the spring semester of your Junior year before you leave for summer vacation (starting April 23, 2012). You **must** do it no later than **September 7, 2012**.

- Have the attached Senior Exercise Faculty Mentor Form signed by your selected mentor and return it to the Department Office.

Assignment 1: 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**, and cannot have been used in the context of a course. 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. 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:

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

Assignment 2: Paper Summary and Annotated Bibliography

The purpose of writing a summary of the paper is to demonstrate your understanding of its content. The summary should function much as an abstract does by relating key information on the question, experimental design, and results presented in the paper. The summary should be no more than 500 words. It should be revised and handed in with the manuscript and final versions of your senior exercise.

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:

Krebs, C.J., R. Boonstra, S. Boutin, and A.R. Sinclair. 2001. What drives the 10-year cycle of snowshoe hares? *BioScience* 51: 25 - 35.

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.

Assignment 3: An Essay in Three Parts

Part 1: 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 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 limitations of other approaches to the same question. Are the model system and experimental design(s) appropriate? Why or why not?

Data and Interpretation. Focus 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). We expect you to deal concretely with the data, for example by pointing out particular features of the figures or tables, and by making numerical comparisons.

Strong essays will identify and discuss both the strengths and limitations 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 an *analysis* with a *summary* (you've already written 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 analysis, you will likely need to consult and cite other relevant papers. Reading beyond your primary paper will also contribute to your efforts on the remaining two parts of your essay.
- Focus on the limitations of the study, rather than its faults. The goal is not to criticize the article, but rather to evaluate its strengths and weaknesses.

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 other sub-disciplines of biology that you have studied and what is the overall significance of the work? For the latter, consider how previous studies have influenced your paper as well as how your paper has influenced subsequent work in the field of biology.

In composing this essay, draw upon what you have learned in the biology courses that you have taken, and what you have learned from your reading of the literature relevant to your paper. 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. As a strategy you might think first about the implications of your study at one level of biological organization below and one level above the focus of your paper. 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. Effective use of the literature is a key to success in this section. You'll need to read broadly on topics related to your paper. Although you may use secondary sources such as textbooks and review articles as a starting point for thinking about the biological context, your writing should focus on analysis of relevant primary literature. Be sure to reference the relevant texts or literature used in your synthesis.
- Your essay must span several levels of biological knowledge that are **biologically relevant** to the topic of your paper. For example, if the main focus of your journal article is population biology, you might aim to relate it to landscape ecology, organismal biology, and population genetics. If the main focus of your journal article is cellular biology, you might aim to relate it to organismal biology, molecular biology, evolution, and/or human disease. Your essay should make explicit links and connections with other areas of the field, including the approaches used to understanding biological systems.

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 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

Moodle and **turnitin.com** will be used to submit work electronically. See the moodle site for updated instructions on uploading work. Pay careful attention to the details of what materials go to which site. In most cases, pdf's of journal articles are submitted to **Moodle**. Original written work is submitted to **turnitin.com**.

All submissions are due by **12 noon** on the due date. See specific submission instructions below for each deadline.

- Sept. 7** [Friday] Final date for commitment to mentor. Faculty mentor form submitted to Mrs. Busenburg-Taylor in the Biology office.
- Sept. 14** [Friday] Three journal articles for consideration by your faculty mentor submitted as PDF documents to **Moodle**.
- Sept. 24** [Monday] Paper Summary and Annotated bibliography submitted in electronic form to **Turnitin.com**. Note that mentors may also require paper copies at their discretion.
- Oct. 19** [Friday] Complete manuscript version of essays and paper summary in electronic form as a single document to **Turnitin.com**. Also submit your focal journal article as a PDF document via **Moodle**. Note that mentors may also require paper copies at their discretion.
- Nov. 16** [Friday] Revised manuscript including the **three essays, paper summary, references cited, and title page** in electronic form as a single document to **Turnitin.com**. The title page must include your name and your mentor's name, the full citation of your focal paper, and the word count for each of the three essays. Note that the word count includes references that you insert into the text, but does not include the references cited section. All sections of your manuscript, including the paper summary, should be revised. Also submit the **focal research article** that you analyzed and the **most pertinent primary literature cited** (5-10 primary sources) as PDF documents via **Moodle**. Note that mentors may also require paper copies at their discretion.

Due dates are non-negotiable. If any deadline is not met, the Dean for Academic Advising 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.

- Failure to meet a deadline automatically results in loss of eligibility for distinction.
- Time stamps on Moodle or at Turnitin.com define on-time submission.
- Without successful and timely completion of the senior exercise you cannot graduate.

All drafts submitted must show professional English style and usage throughout, including page numbers and proper reference format. 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, 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. Never use quotes, but rather describe things as you understand them. The submission of your essays at Turnitin.com automatically checks for plagiarism. Results of this check are available to you prior to each deadline.

Your faculty mentor will assign a second reader. Each Senior Exercise will be read by at least two faculty members and the department as a whole 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**.

The results of your ETS exam are a pre-requisite to earning distinction on your senior exercise. Distinction is rewarded when your work is judged to be of “A” quality on both the essays and the ETS exam.

Citations and References

Citations and references must be done using the standard Biology Format in use in Biol 109-110. That segment from the Biol 109-110 Lab Manual is excerpted below.

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 . . .
or . . . (Daniel, 1968 cited in Jones, 1977).

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 close paraphrasing in your essays. 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. **A single *References Cited* section** should be provided that covers the references for all three essays and your summary.

Journal article:

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

Example:

Ketel, D. H., H. Breteler and B. de Groot. 1984. Effect of explant origin on growth and differentiation of calli from *Tagetes* species. *J. Plant Physiol.* 118: 327-333.

A book in which each chapter is an article written by a different author(s):

Name(s) of author(s). year. 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:

Henricks, S. B. and H. A. Borthwick. 1965. The physiological functions of phytochrome. In: *Chemistry and Biochemistry of Plant Pigments*, ed. T. W. Goodwin. Academic Press, London, pp. 239-266.

A book with one author (or group of authors):

Name(s) of author(s). year. *title of book*. publisher, location of publisher, # of pages in the entire book.

Example:

Lehninger, Albert L. 1965. *Bioenergetics*. W. A. Benjamin, Inc. New York, 350 pp.

The following is a list of criteria that the Biology department uses when assessing senior exercise essays. Students should refer to the full senior exercise guidelines for detailed instructions for each essay. We share this with students as a supplementary indication of our expectations. We caution against use of this list as a simple checklist. Simply addressing each criterion does not necessarily guarantee a satisfactory senior exercise.

1. Analysis (particularly essay 1):

- Evaluates the study's model system, experimental design, and techniques.
- Describes study's results and how well they support its conclusions.
- Explores both strengths and weaknesses of the article
- Directly discusses actual data and figures from the article.
- Proposes alternate approaches, experiments, analyses or controls that could improve the study.
- Compares and contrasts methods and results to those of similar research articles.

2. Synthetic ability (particularly essay 2):

- The article is placed in an appropriately broad, integrative biological context. The essay extends beyond the material covered in the introductory lecture course that the paper would fall into.
- The essay articulates why someone in another field would benefit from reading the article. It shows how the paper has influenced other fields or how it has been influenced by other fields.
- Primary literature is used as a foundation for integrating disciplines.
- The overall significance of the article is clearly described.

3. Creative thinking (particularly essay 3):

- Important further research questions are identified.
- Appropriate experimental designs are proposed.
- Hypotheses are clearly stated, and results that would contradict or support hypotheses are proposed.
- Proposed experiments use methodologies and approaches different from the paper's.
- Possible experimental or interpretive difficulties are mentioned.
- Proposed experiments demonstrate an understanding of the relevant primary literature.

4. Written skill (all 3 essays):

- Each essay is well organized.
- The writing is succinct, clear, and direct.
- Grammatical and spelling errors are absent.
- Proper citation format is used.

5. Comprehension of material content (all 3 essays):

- Concepts are explained accurately.
- A deep understanding of the paper's research area is demonstrated.
- Primary literature is effectively used to support arguments. At least 10-15 primary research articles are incorporated into the essays.

The Biology Seminar Series: Information for Students

Why do we require seniors and research students to attend seminars?

- The seminar series is an important part of our departmental emphasis on the process of science. Just as you have learned about the process of science by reading research papers in classes, you will also learn about how science works by attending seminars.
- Seminars are a common means for communicating scientific information, and being comfortable with this format is an important skill for biologists.
- The seminar series is also an important opportunity for both students and faculty to interact with scientists from other institutions. We often invite students to have lunch or dinner with seminar speakers – if you'd like to be invited, let us know.

What sort of information is presented in a seminar?

- In a typical research seminar, the speaker will present findings and ideas that are not yet published. Thus, the content in a research seminar may be less polished or less finished than the final product that is printed in a peer-reviewed journal.

What are the benefits to the speaker and the audience?

- Speakers benefit by presenting their work at an early stage. They receive important feedback from the audience, usually in the form of questions during or after the seminar.
- The audience benefits by hearing about results before they reach print form. Students can benefit by seeing an actual example of how scientists interact with each other in the real world.

How can I enjoy and benefit from my seminar attendance?

- Prepare beforehand. If you have the chance, read a paper written by the seminar speaker or read a review article on the topic. Having an understanding of the topic before the seminar will greatly enhance your enjoyment and understanding.
- Take notes. Generally, research seminars move fast and speakers often lapse into the jargon of their discipline. It is possible to get swamped by a tsunami of vocabulary. The beginning of a research seminar usually contains background on the research area, similar to the Introduction section of a paper. It helps to jot down unfamiliar names and acronyms. Later in the talk you might forget that eNAC stands for epithelial sodium channel, that TEWL is total evaporative water loss, or that a pika is a short-eared mammal that lives at high altitudes. Having your notes to remind you, you'll be able to keep up with the talk.
- Think critically. When reading a research paper, scientists try to critically evaluate the evidence that is presented. Try to do the same during a seminar. Look carefully at the data. Do they support the stated conclusions? Even if you miss some of the details, you can always assess the quality of the data that are presented.
- Understand what you can. You may not understand every aspect of a research seminar, especially if it is outside of your major area of biology. Don't worry about it. Probably only a few experts in the field understand the work entirely. And even the speaker may not exactly know how everything fits together. Remember that speakers often present research in progress and there are almost certainly aspects that are still not understood.
- Observe how effectively the speaker presents the seminar. You can learn a lot by watching how scientists present their work. Are the slides clear? Did the speaker give enough background information? Are the data presented effectively? Even if you don't understand a word of the science, you can learn how to effectively present your work. You might also note some mistakes and vow never to make them yourself.
- Ask questions: You are encouraged to ask questions at seminars. Our students often do, and speakers are appreciative and impressed.
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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 7, 2012.