Biology Major Program Revision

Program Proposal Checklist

* Program Abbreviated Title: Bachelor of Science in Biology
  (29 characters maximum)
* Program Complete Title: Major in Biology for the Bachelor of Science Degree

Program Description (100 words maximum for catalog)
The major in Biology consists of six required Biology courses, six required cognate courses, six electives, and a capstone course. The required Biology and cognate courses provide a broadly based background in Biology and related sciences, while the electives provide the opportunity for students to tailor their studies to reflect their career goals. The capstone courses emphasize integration of skills and knowledge obtained in the more structured courses. Students are strongly encouraged to consult the Biology Website (http://orion.neiu.edu/~biology/) and/or their Biology Advisor for electives that are recommended for specific career paths.

Program Prerequisites: Before enrolling in any Biology courses that count towards the major, all students must meet the following criteria. Score of 6 on the reading placement test, a score of 7 or better on the writing placement test, and a score of 2 or better on the Math placement test.

Required Biology Courses:

6 core courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL-150</td>
<td>Essential Skills for Biologists</td>
<td>2 cr</td>
</tr>
<tr>
<td>BIOL-201</td>
<td>General Biology I</td>
<td>4 cr</td>
</tr>
<tr>
<td>BIOL-202</td>
<td>General Biology II</td>
<td>4 cr</td>
</tr>
<tr>
<td>BIOL-301</td>
<td>Cell Biology</td>
<td>4 cr</td>
</tr>
<tr>
<td>BIOL-303</td>
<td>General Genetics</td>
<td>4 cr</td>
</tr>
<tr>
<td>BIOL-305</td>
<td>General Ecology</td>
<td>4 cr</td>
</tr>
</tbody>
</table>

Five elective courses, four of which must be biology courses, one can be biology or other science (see below), four must include a lab component, one lab course must focus on plants, and one must focus on animals. Students should check with their advisors to verify which courses satisfy this requirement.

1 capstone course BIOL-390, 391, 392 & 393, or 394 3-4 cr

Total Biology credits 44-46

Required Cognate Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM-211</td>
<td>General Chemistry I</td>
<td>5 cr</td>
</tr>
<tr>
<td>CHEM-212</td>
<td>General Chemistry II</td>
<td>4 cr</td>
</tr>
<tr>
<td>CHEM-231</td>
<td>Organic Chemistry I</td>
<td>4 cr</td>
</tr>
<tr>
<td>MATH-106</td>
<td>Pre-calculus Mathematics</td>
<td>4 cr</td>
</tr>
<tr>
<td></td>
<td>2 semesters of Physics with lab, either algebra based (201 &amp; 202), or calculus based physics (206 &amp; 207).</td>
<td>8 cr</td>
</tr>
</tbody>
</table>

Total Cognate credits 25

Total credits for major 69-71

Cognate Electives:
One of the five electives can be a course offered by another department. Students must check with the Biology Department for a current list of approved cognate electives before registering for such courses. Courses from other departments that are not on the current approved list, will not be accepted as electives for the Biology Major.

URL: http://orion.neiu.edu/~biology/
Biology Major Program Revision

Before submitting a proposal, please indicate whether each of the following tasks have been fulfilled

<table>
<thead>
<tr>
<th>Task</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does the program proposal include a rationale?</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Does this proposal require coordination with other departments in the College or University? If so, please attach supporting documentation.</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3. Are there adequate library resources (print and media) to support this proposal? If not, state how resources would be developed or how the proposal would be affected.</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4. Are additional resources (staff, fiscal, or technical, including lab space and equipment) required to support this proposal? If so, please identify the resources. If those resources are not available, state how the proposal would be affected.</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5. Has academic computing been consulted regarding the adequacy of resources (lab space, hardware and software) to support this proposal? If computing resources are not available, describe how those resources would be developed or how the proposal be affected.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6. If this proposal concerns a 300-level course to be offered for graduate credit, is the required academic rationale attached? It is suggested that program changes be presented in the form of a table, with rationale for each change.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>7. Is the course syllabus for any new or revised required courses attached in support of this proposal? (See syllabus requirements for course proposals)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>8. Are all supporting documents attached?</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rationale

1. Overview: The Biology Faculty propose to revise the curriculum leading to a Bachelor of Science in Biology degree. The current curriculum was devised more than 20 years ago, and as such does not reflect the needs of today’s Biology Majors. Many of the courses listed in the catalogue are outdated and irrelevant, while others cannot be taught due to a lack of faculty with expertise/training in those disciplines.

General goals of revision:
- Remove outdated/irrelevant courses from the catalogue, upgrade some existing courses to better reflect current standards in Biology teaching, and add new courses that are essential components of a modern Biology program.
- Consolidate and update the undergraduate Biology Major program. Currently, students choose between three areas of emphasis, each of which has its own required Biology and Cognate courses, and recommended electives. Keeping track of the three different programs and ensuring that all essential courses are taught on a regular basis has become increasingly difficult, as enrollments have increased and the number of tenure-track faculty has decreased. The necessity of offering a large number of required courses has impeded our ability to offer elective courses that reflect the interests and needs of our students. Consolidating to one program, with a core curriculum that all Biology majors take will free up teaching CUs, which can then be used to ensure that the students have a wide selection of elective courses to choose from, allowing them to tailor their course work to reflect their career goals.
- Increase student participation in research. Students who have research experience will be more competitive for jobs in a number of biotech related fields, and/or for acceptance into post-baccalaureate programs. In the revised curriculum, students will be required to take a capstone course: one option for the capstone course will be Independent Research.
Biology Major Program Revision

- Standardize the lecture time and credits received for lab courses. Currently some courses that include a laboratory component are three credits while others are worth four credits. The three credit lab courses are holdovers from when NEIU was on the quarter/trimester system. In the semester system, a three-credit laboratory course does not provide enough class time to adequately cover the material, and still provide the students with meaningful lab experience. In the revised curriculum, all courses that include a weekly laboratory component will be four credit courses.

- More clearly define the goals of the Biology undergraduate program, and establish assessment criteria for determining whether those goals are being met.

- Organize all of the biology courses into a single numbered series (BIO-xxx). Currently courses may be listed under biology (BIOL), botany (BOT), or zoology (ZOOL). Having a single series will simplify the course listings in the catalogue and class schedule, making it easier for students to determine whether the courses they are interested in are being offered during a particular semester.

Program Goals: The goals of the Biology program are to ensure that, upon graduation, our students are prepared for entering the job market and/or an advanced program of study. Students graduating from NEIU with a Bachelor of Science in Biology will: (Taken from the Biology Department Mission Statement)

1. Have a broad understanding of Biological Principles.
2. Be proficient in the use of standard Biological Techniques.
3. Understand the scientific method, including formulation and testing of hypotheses and evaluation of results.
4. Know how to keep an effective laboratory or field notebook.
5. Have developed critical observational, thinking and reasoning skills.
6. Have developed good oral communication skills.
7. Have developed good written communication skills.
8. Be competent in the effective use of the library and internet for research.
9. Be able to read and evaluate the scientific literature.

2. Outcomes:

   See attached Matrix

3. Assessment Criteria: That students have achieved an acceptable level of competence in each of the program goals will be demonstrated through the following methods.

   Minimum Grade Requirements- Enforcement of the rule that all students must achieve a grade of “C” or better in all prerequisites before registering for a course will improve students preparation for courses, and thus improve their understanding of material at each level. This will address goal 1.

   Passing grade on the MFAT exam- This exam will be administered to students registered for any of the capstone courses, and will demonstrate whether the student has a broad understanding of Biological Principles. This will address goal 1.

   Hypothesis design and testing- Many of the required and elective courses, require that students identify a question for study, formulate a hypothesis to answer the question and design experiments to test the hypothesis. Completion of these courses with a grade of “C” or better will indicate that the student has a solid understanding of the Scientific Method. In addition, the capstone courses will require that students demonstrate the ability to apply the concepts of scientific method, and integrate information from multiple courses to research specific scientific questions, or apply the information in novel situations. These requirements address goals 3 & 5.
Biology Major Program Revision

**Capstone courses-** These courses will require 3 or more of the following: literature search, literature review, experimental design/execution, written presentations, oral presentations. These courses will address all of the goals.

**Alumni questionnaires-** Former students will be surveyed at 1, 5 and 10 year intervals to determine whether and how they are using the knowledge and skills acquired in the Biology program in their jobs or post baccalaureate educations.

4. **The information about student performance gathered in (3) will be used in the following ways to improve future students' performance.**

Enforcement of the “C” grade rule, and the requirement that prerequisites be completed and passed, before a student can register for a course, should insure that students are adequately prepared for upper level courses. If after beginning enforcement of these rules, significant numbers of students are still struggling in upper level courses, then we will assess the entry and lower level courses to determine if deficiencies exist in the material covered in these courses. If deficiencies are identified, action will be taken to correct such deficiencies (e.g. upgrading/updating course content).

The MFAT exam will allow us to evaluate how well our biology majors grasp a broad spectrum of biological principles. If our students consistently score low in specific subject areas, relative to the national average, we will implement changes to ensure that greater emphasis is placed on those areas of study. The MFAT will also allow us to compare the overall performance of our majors to that of biology majors throughout the United States, and determine whether our students are likely to be competitive in the national job market.

A capstone course is an ideal forum for the instructor to evaluate the knowledge and skills learned in the core biology courses. Since the capstone courses will require students to apply their knowledge and skills, the instructor(s) will be able to identify general weaknesses shared by multiple biology majors. If weaknesses in understanding of biological concepts or skills are identified, we will implement changes to further stress these concepts and/or skills in the appropriate courses.

Alumni questionnaires will be used to evaluate whether the Biology curriculum is successful in preparing students for the current job market and/or post baccalaureate training. Since biology is a rapidly changing field, it is anticipated that course offerings and/or course content will be revised periodically to ensure that our program meets the educational/training needs of our students and society.

5. **How the program will prepare students for multiple careers or life-long learning.**

The revised Biology curriculum will provide students with a broad knowledge base and tools, which will allow them to choose among a wide variety of career paths including, science education, ecology/environmental science, all areas of the health professions field, forensics, environmental and patent law, food production and processing, bio-defense, and research. The broad knowledge base gained by the students will enable them to stay abreast of advances in their chosen fields after graduation. Students graduating with a Bachelor of Science in Biology will be able to choose between entering the work force in an entry-level position, or obtaining advanced training in a professional or graduate program. Those who decide to change career paths in the future will benefit from the broad knowledge base, which will allow them to move laterally rather than having to retrain completely. In addition, the increased emphasis on the scientific method in the revised curriculum will provide students with problem solving skills that can be applied to many life situations.

See the accompanying course proposal checklists and other supporting documents, for syllabi etc.
<table>
<thead>
<tr>
<th>Objective</th>
<th>Undeveloped</th>
<th>Emerging</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Has a broad understanding of Biological Principles.</td>
<td>Cannot explain or apply biological principles.</td>
<td>Can explain, but cannot apply basic biological principles.</td>
<td>Can explain basic and advanced principles, and can apply basic principles.</td>
<td>Can explain and apply advanced biological principles.</td>
</tr>
<tr>
<td>2. Is proficient in the use of standard Biological Techniques.</td>
<td>Requires supervision in the use of basic techniques.</td>
<td>Is proficient in the use of basic techniques, but requires supervision for advanced techniques.</td>
<td>Is proficient in the use of basic and advanced techniques.</td>
<td>Is proficient in the use of basic, and advanced techniques, and can apply to novel projects.</td>
</tr>
<tr>
<td>3. Understands the scientific method, including formulation and testing of hypotheses and evaluation of results.</td>
<td>Does not understand or know how to apply the scientific method.</td>
<td>Understands how to apply the scientific method to simple examples, requires help with experimental design and analysis.</td>
<td>Can apply the scientific method to simple and more complex examples, with minimal help.</td>
<td>Understands the scientific method and can apply to novel situations.</td>
</tr>
<tr>
<td>4. Knows how to keep an effective laboratory or field notebook.</td>
<td>Does not keep an effective notebook. Notebooks are disorganized and incomplete.</td>
<td>Keeps notebook in standard format, but material is incomplete, disorganized or lacks clarity.</td>
<td>Uses scientific format effectively. Entries can be used for data analysis.</td>
<td>Uses scientific format effectively. Notes can be used as a guide for similar future experiments.</td>
</tr>
<tr>
<td>5. Has developed critical observational, thinking and reasoning skills.</td>
<td>Is only capable of repeating what he/she has read or been told.</td>
<td>Observational skills have developed to point where can see beyond the obvious, but has difficulty putting into context.</td>
<td>Sees beyond the obvious and can put knowledge into context.</td>
<td>Can put knowledge into context, and understands relationship to other biological principles.</td>
</tr>
<tr>
<td>6. Has developed effective oral communication skills.</td>
<td>Has great difficulty expressing self orally.</td>
<td>Can usually get point across orally, but is not fluent.</td>
<td>Gives good oral presentations but doesn’t engage the audience.</td>
<td>Oral presentations are excellent, engages the audience.</td>
</tr>
<tr>
<td>7. Has developed effective scientific writing skills.</td>
<td>Has difficulty expressing ideas in coherent sentences.</td>
<td>Can usually put ideas into coherent sentences and paragraphs, but needs significant editing help.</td>
<td>Writing is generally clear, but needs some editing help.</td>
<td>Writing is clear and coherent, requires minimal editing.</td>
</tr>
<tr>
<td>8. Is competent in the effective use of the library and internet for research.</td>
<td>Needs assistance for even basic searches.</td>
<td>Can accomplish basic searches, but needs help with detailed searches.</td>
<td>Is moderately competent in the use of the library and internet for research.</td>
<td>Is competent in the use of the library and internet for research.</td>
</tr>
<tr>
<td>9. Is able to read and evaluate the scientific literature.</td>
<td>Cannot read and understand papers from the scientific literature.</td>
<td>Can read and understand review articles written for the general science community.</td>
<td>Can read and understand articles written for the research community.</td>
<td>Can read, understand, and critique articles written for the research community.</td>
</tr>
</tbody>
</table>
### Comparison Table for old and new Biology Major requirements

<table>
<thead>
<tr>
<th>General Biology Emphasis</th>
<th>Environmental Emphasis</th>
<th>Pre-professional Emphasis</th>
<th>New Biology Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL-150 Basic Skills for Biologists (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology of Organisms (3)</td>
<td>Biology of Organisms (3)</td>
<td>Biology of Organisms (3)</td>
<td>BIOL-201 General Biology I (4)</td>
</tr>
<tr>
<td>Biology of Organisms (3)</td>
<td>Biology of Organisms (3)</td>
<td>Biology of Organisms (3)</td>
<td>BIOL-202 General Biology II (4)</td>
</tr>
<tr>
<td>Cell Biology (4)</td>
<td>Cell Biology (4)</td>
<td>Cell Biology (4)</td>
<td>BIOL-301 Cell Biology (4)</td>
</tr>
<tr>
<td>Genetics (3)</td>
<td>Genetics or Evolution (3)</td>
<td>Genetics (3)</td>
<td>BIOL-303 General Genetics (4)</td>
</tr>
<tr>
<td>Biochemistry (4)</td>
<td>Ecological Methods (4)</td>
<td>Biochemistry (4)</td>
<td></td>
</tr>
<tr>
<td>Ecology (3)</td>
<td>Ecology (3)</td>
<td>Ecology (3)</td>
<td>BIOL-305 General Ecology (4)</td>
</tr>
<tr>
<td>A morphology course (3 choices) (3)</td>
<td>Plant Morphology (3)</td>
<td>A morphology course (3 choices)</td>
<td></td>
</tr>
<tr>
<td>An animal morphology course (2 choices) (3)</td>
<td>Animal Kingdom recommended (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A physiology course (2 choices) (4)</td>
<td>A physiology course (2 choices) (4)</td>
<td>A physiology course (2 choices)</td>
<td></td>
</tr>
<tr>
<td>Local Flora or Local Fauna (3)</td>
<td>Vertebrate Physiology recommended (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 credits of Internship in Environmental Biology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 credit hours of Biology electives (3-4 courses)</td>
<td>2 Biology electives (6-8)</td>
<td>12 credit hours of Biology electives (3-4 courses)</td>
<td>5 electives, 4 must be biology, 1 can be biology or other science (19-20)</td>
</tr>
<tr>
<td>Gen Chemistry I (5)</td>
<td>Gen Chemistry I (5)</td>
<td>Gen Chemistry I (5)</td>
<td>Gen Chemistry I (5)</td>
</tr>
<tr>
<td>Physical Geology (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 semesters of physics w/ lab (8)</td>
<td>2 semesters of physics w/ lab (8)</td>
<td>2 semesters of physics w/ lab (8)</td>
<td>2 semesters of physics w/ lab (8)</td>
</tr>
<tr>
<td>Pre-calculus Mathematics (4)</td>
<td>Pre-calculus Mathematics (4)</td>
<td>Pre-calculus Mathematics (4)</td>
<td>Pre-calculus Mathematics (4)</td>
</tr>
<tr>
<td>2 Cognate electives (6-8)</td>
<td></td>
<td>2 Cognate electives (6-8)</td>
<td></td>
</tr>
<tr>
<td><strong>Total # of courses 18-19</strong></td>
<td><strong>Total # of courses 19</strong></td>
<td><strong>Total # of courses 18-19</strong></td>
<td><strong>Total # of courses 18</strong></td>
</tr>
<tr>
<td><strong>Total Credits 66-68</strong></td>
<td><strong>Total Credits 67-69</strong></td>
<td><strong>Total credits 66-68</strong></td>
<td><strong>Total credits 69-71</strong></td>
</tr>
</tbody>
</table>

Credits for individual courses are shown in parentheses.
Proposed Capstone Courses

Biology Seminar (3 cr hrs):
Goals:
   a. To assess whether students are able to critically read primary research papers.
   b. To assess whether students can communicate scientific information/knowledge competently via written and oral presentations and discussions.
   c. To assess whether students are able to integrate knowledge gained from different courses and/or disciplines.

Requirements:
   a. Each student will be required to do two oral presentations (specific topics subject to faculty approval), and provide written summaries of the two topics.
   b. Each student will also be required to do up to 4 peer evaluations of presentations by classmates.
   c. Each student will be required to take the MFAT (Major Field Achievement Test).

Internship (3 cr hrs):
Goals:
   a. To provide students with the opportunity to work in a professional environment.
   b. To provide students with enhanced training in a specific sub-discipline, and experience with how science is done in the real world.
   c. To enhance possible career opportunities, or provide practical applications of methods taught in class.
   d. To assess whether students can communicate scientific information/knowledge competently via written and oral presentations, and discussions.
   e. To assess whether students are able to integrate knowledge gained from different courses and/or disciplines.

Requirements:
   a. The student will identify and receive approval for a relevant field experience with a suitable off campus supervisor, and a NEIU Biology faculty mentor no later than the term before the term of the internship.
   b. The student will keep and turn in a journal of activities.
   c. The student will request a letter of evaluation from their off campus supervisor, regarding the quality of the student's work. The letter will be submitted directly to the faculty mentor.
   d. The student will write a report summarizing the activities of the internship and placing those activities in the context of relevant literature. The specific format of the report will be designed by the NEIU Biology Faculty.
   e. Each student will be required to take the MFAT (Major Field Achievement Test).
Independent Research (2x2 cr hrs or 1x4 cr hrs):

Goals:

a. To provide students with enhanced training in a specific sub-discipline, and experience with how science is done in academic research settings.

b. To assess whether students can communicate scientific information/knowledge competently via written and oral presentations and discussions.

c. To assess whether students are able to critically read papers and articles from the primary scientific literature.

d. To assess whether students are able to integrate knowledge gained from different courses and/or disciplines.

Requirements:

a. The student will identify a Biology faculty mentor who is willing to advise and guide the research experience no later than the term before he/she registers for Independent Research.

b. In consultation with the faculty mentor, the student will identify an area of interest for her/his research project.

c. The student will do a literature search of the area, identify a specific question to be addressed, and write a research proposal that includes citation of the appropriate literature.

d. In consultation with the faculty mentor, the student will design and execute experiments to answer/address the research question.

e. The student will present his/her research results in a public forum, and provide a written summary of the research, in the format of a scientific paper.

f. The student will be required to take the MFAT (Major Field Achievement Test).

With advance approval from the Biology Department, students who participate in a summer research program at another university may be allowed to use that experience for the research component of the independent research course. The students will be required to register for the full number of capstone credits, even though the initial research was done elsewhere, and will be required to fulfill requirements d and e from above.

Seminar in Teaching of Biology (Alternative title- Teaching Methods in Post-secondary Biology) (3 cr hrs):

Goals:

a. To provide students with the opportunity to gain practical experience with methods of post-secondary teaching in the biological sciences.

b. To assess whether students are able to integrate knowledge gained from different courses and/or disciplines.

C. To assess whether students can communicate scientific information/knowledge competently via written and oral presentations and discussions.

d. To assess whether students are able to critically read papers and articles from the primary scientific literature, and integrate relevant information into course material.

Requirements:

a. The student will identify a Biology faculty mentor who is willing to advise and guide the teaching experience no later than the term before he/she registers for Seminar in Teaching of Biology.

b. Student will assist in designing and presenting lecture material, including material from current/recent literature.

c. Student will assist in designing, setting up and directing lab exercises.

d. Student will assist in designing and grading quizzes and exams.

e. Student will be expected to comply with common standards of academic honesty.

f. Student will be required to take the MFAT (Major Field Achievement Test).
LIST OF COGNATE COURSES APPROVED TO COUNT AS A BIOLOGY ELECTIVE IN THE NEW CURRICULUM
(only one is allowed per customer)

### ANTHROPOLOGY
- ANTH-332 Human Growth & Development in Evolutionary Perspective
- ANTH-339 Paleoanthropology
- ANTH-356 Human Variation
- ANTH-370 Forensic Anthropology
- ANTH-376 Primate Behavior

### CHEMISTRY
- CHEM-213 Quantitative Analysis
- CHEM-232 Organic Chemistry II
- CHEM-331 Instrumental Analysis: Quantitative Methods

### EARTH SCIENCES
- ESCI-306 Rocks & Minerals
- ESCI-309 Geochemistry
- ESCI-312 Historical Geology
- ESCI-315 Glacial & Quaternary Geology
- ESCI-320 Limnology
- ESCI-328 Marine Geology
- ESCI-329 Soil Science
- ESCI-335 Meteorology
- ESCI-337 Principles of Hydrogeology

### GEOGRAPHY & ENVIRONMENTAL STUDIES
- G&ES-319 Natural Resources: Policy & Planning
- G&ES-371 Geomorphology
- G&ES-OC-325 Oceanography II

### HPER – PHYS. ED. MAJOR THEORY
- HPER-PEMT-302 Kinesiology
- HPER-PEMT-306 Physiology of Exercise

### MATHEMATICS
- MATH-187 Calculus I (formerly Math-107)
- MATH 275 Statistics

### PHILOSOPHY
- PHIL-375 Philosophy of Science

### PHYSICS
- PHYS-215 Physics III
- PHYS-308 Introductory Mathematical Physics
- PHYS-309 Fortran & Numerical Analysis for Scientists
- PHYS-331 Optics
- PHYS-335 Thermodynamics & Kinetic Theory
- PHYS-361 Materials I: Structural, Mechanical & Thermal Properties

### PSYCHOLOGY
- PSYC-202 Statistics & Research Methods I

Approved 24 April 2007 by the Dept. of Biology
Lecture Assignment Examples, BIO 100, Spring 2008

1. An important goal of BIO 100 is to gain enough biology background to better understand or appreciate important biological issues in the news. Find one news article related to any aspect of biology— even a topic we haven’t covered yet! Biology is the “study of life,” so any article related to living organisms or nature would be appropriate. I will choose one of the articles for the basis of our class discussion next week.

How to find an article? Some suggestions:

a) Read any newspaper
b) Use NEIU's free subscription to the Chicago Tribune. Go to http://www.neiu.edu/~neiulib/ and click on "Databases," then "C." Scroll down and click on the Chicago Tribune. (If you are off campus, you will need to enter your NEIUport login & password.) Then, type in any biology-related search word (photosynthesis, global warming, bacteria, fatty acids, etc.) that is of interest to you.

b) Go to www.cnn.com and use the search box at the top of the page.

2. A friend is rushed to the hospital after suffering a severe allergic reaction to a bee sting. She asks you (the biology expert), “I don’t understand how this could have happened. I was stung by a bee before, but didn’t have a reaction.”

Answer the following questions.

a) Explain the process by which B-cells produce antibodies as part of the primary immune response. In your answer, include an explanation of why a B-cell compatible to bee antigens is likely to exist in a person’s body.

b) Explain the process of the secondary immune response, including the role of “clonal” cells and “memory cells.”

c) Based on the answers to #1 and #2, explain to Sue why her allergic response was more intense the second time she was stung by the bee.

3. A population of snails has recently become established in a new region. The snails are preyed on by birds that break the snails open on rocks, eat the soft bodies, and leave the shells. The snails occur in both striped and unstriped forms. In one area, researchers counted both live snails and broken shells. Their data are below.

Living snails: 264 striped, 296 unstriped
Broken snail shells: 496 striped, 377 unstriped

Answer the following questions.

a) Which snail form is more subject to predation by birds?

b) Hypothesize about the environment that these snails live in. What about the environment might make one of the snail forms more subject to predation?

c) Predict how the frequencies of striped and unstriped individuals might change over generations. Explain the reasons for your prediction.
BIO 100 MACROMOLECULES I-II LAB

Objectives:
1. Correlate the energy in food with the energy needed for all living organisms
2. Correlate the molecules in food with the components necessary for building our own macromolecules
3. Design and carry out a scientific experiment

Background
You will take a quiz on this material before you come to lab this week. Be sure to login to Blackboard and take your quiz before lab. The quiz will be based on the following background information.

This is a two week lab exercise. During the first week you will familiarize yourself with the reagents (chemicals) commonly used to identify the macromolecules of life in solution. During the second week you will demonstrate how to use the reagents from week 1 to test common food substances for the presence or absence of sugars, starch, lipids, and proteins. During this week you will also be asked to design and conduct your own experiment to determine whether or not foods and substances of your choosing contain each of the macromolecules of life.

When we eat a properly balanced diet, we present our digestive system with all of the necessary macromolecules of life. The digestive system, when working properly, breaks down the food we’ve eaten into its component building materials. Our cells will use these macromolecules for daily functioning. For example, if a person were to eat a sandwich consisting of whole wheat bread, meat, and cheese, the digestive system would break down this food into all of the major macromolecules of life.

One type of food we need to eat in order to obtain the macromolecules of life is carbohydrates. The whole wheat bread in our sandwich is a good example of a complex carbohydrate. Carbohydrates include both sugars and starches (which are composed of glucose sugars linked together) and are used by our bodies for a quick and accessible source of energy. One gram of carbohydrate can be converted into 4 calories by our body’s energy converting machinery. Carbohydrates can also be converted into more long-term energy storage units. We can test for the presence of both sugars and starches chemically in the laboratory.

Lipids (fats) are another important source of macromolecules that we gain from food. The meat and cheese in our sandwich example will provide a certain amount of fat for the digestive system to break down. Fats are a necessary part of the diet and are used widely throughout the body. A major example of our use of fat in cells is energy storage. One gram of fat can be converted into 9 calories by our body’s energy converting machinery; therefore a fat contains more than twice as much potential energy as a carbohydrate! Other important examples of how our cells use fats include: insulation, building of cellular membranes, production of cholesterol, and formation of our sex hormones. When a fat is digested it yields three fatty acids and a glycerol molecule. We can use these digestion products in the laboratory to identify whether or not a test solution contains fat.
Lipids, unlike the polar molecule water, are non-polar. Therefore, lipids and water do not “get along” very well chemically speaking. Since our cells contain a lot of water and in fact use water to digest the fat particles that we eat, our cells need some help to digest fats. The help comes from emulsifiers that are attracted to both water and fats and can bring the two together, much like dish soap helps water and grease on your pans interact so that you can clean the pan.

By eating meat and cheese in our sandwich, we provide our cells with a source of protein, another important macromolecule of life. Proteins are made of amino acids that are linked together by peptide bonds. Using our digestive system, we break down food proteins into amino acids and use those amino acids to build our own proteins so that our cells can function properly. Like fats, we can plug proteins and amino acids into our energy processing system when necessary (long periods of fasting) to access energy. One gram of protein will provide 4 calories of energy, just like carbohydrates. In this lab we will test for the presence of proteins in solution using chemicals that change color when they interact with proteins and/or amino acids.

The last of the macromolecules of life are the nucleic acids, DNA and RNA. They are composed of a backbone of sugar and phosphate molecules bonded together in a chain with nitrogenous bases attached to each sugar. We will not be considering nucleic acids in this laboratory procedure.

### Macromolecules I

#### Reagent Determination Experiment

You will use three types of chemicals in this experiment. The chemicals will change color in the presence of a particular macromolecule of life, given the appropriate conditions. Your job is to determine which of the chemicals detects which of the macromolecules. Follow the procedures outlined below for each of the three reagents to answer this question.

Notice that each procedure includes a test tube (#1) that contains only distilled water. This tube is a negative control - a tube that you know gives a negative result. The negative control is used for comparison with your experimental tubes.

**Early Preparation:**
Start a boiling water bath by placing a 500mL beaker filled with 250mL of tap water on your hot plate. Turn the hot plate to the highest setting and allow the water to boil. Be very careful not to burn yourself. When finished with the hot plate, turn it to its lowest setting, unplug it, and wind its cord so that it is out of the way.

**Procedure for Reagent #1:**

Record the original color of Reagent #1 below. Label five test tubes #1-5 with a wax marking pencil as close to the top of the tube as possible. Using a ruler and a wax pencil, make a mark on each test tube at the 1 cm and 2 cm level (from the bottom of the tube).

Fill your test tube to the first mark (1 cm level) with the experimental solution for tubes 1-5 according to Table 1. Fill each tube to the second mark (2 cm level) with Reagent #1. Mix the solution then observe the final color of the solution **IMMEDIATELY.** If you wait too long you may get confusing results. Record your results in Table 1.
Table 1

Original color of Reagent #1: ________________________________

<table>
<thead>
<tr>
<th>Tube #</th>
<th>Experimental Solution</th>
<th>Color of solution after mixing</th>
<th>Which tube had the most intense color change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distilled Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Protein Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Starch Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Strong Sugar Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Weak Sugar Solution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which of the macromolecules of life reacts with Reagent #1?

_____________________________________________________________________

What color does Reagent #1 turn in the presence of the macromolecule?

_____________________________________________________________________

Procedure for Reagent #2:

Record the original color of Reagent #2 below. Label five test tubes #1-5 with a wax marking pencil as close to the top of the tube as possible. Using a ruler and a wax pencil, make a mark on each test tube at the 1 cm and 2 cm level.

Fill your test tube to the first mark (1 cm level) with the experimental solution for tubes 1-5 according to Table 2. Fill each tube to the second mark (2 cm level) with Reagent #2. Mix the tubes well and then place all five tubes in a boiling water bath at the same time for approximately 1 minute. Record any color changes immediately in Table 2.

Table 2

Original color of Reagent #2: ________________________________

<table>
<thead>
<tr>
<th>Tube #</th>
<th>Experimental Solution</th>
<th>Color of solution after boiling</th>
<th>Which tube had the most intense color change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distilled Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Protein Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Starch Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Strong Sugar Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Weak Sugar Solution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Which of the macromolecules of life reacts with Reagent #2?
_____________________________________________________________________
What color does Reagent #2 turn in the presence of the macromolecule?
_____________________________________________________________________

Procedure for Reagent #3

Record the original color of Reagent #3 below. Label five test tubes #1-5 with a wax marking pencil as close to the top of the tube as possible. Using a ruler and a wax pencil, make a mark on each test tube at the 1 cm level.

Fill your test tube to the first mark (1 cm level) with the experimental solution for tubes 1-5 according to Table 3. Add 8 drops of Reagent #3 to each tube. Mix the solution and immediately observe and record the final color of the solution in Table 3.

Table 3

<table>
<thead>
<tr>
<th>Tube #</th>
<th>Experimental Solution</th>
<th>Color of solution after mixing</th>
<th>Which tube had the most intense color change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distilled Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Protein Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Starch Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Strong Sugar Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Weak Sugar Solution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which of the macromolecules of life reacts with Reagent #3?
_____________________________________________________________________
What color does Reagent #3 turn in the presence of the macromolecule?
_____________________________________________________________________
Testing a Common Food Item

Now you will use the information obtained from your experiments to test a common food item for the presence of protein, starches, and sugars. Additionally, you will do a quick test for fats. Conduct each of the experiments you performed above on your food item and determine which of the macromolecules of life your food contains.

Procedure for Detecting Fats in Food:

Place one drop of water on a paper towel or a square of brown paper. Next to the water place a drop of oil solution (positive control). Lastly, place a drop of your dissolved food substance next to the oil drop. Label each drop clearly. Allow 10-15 minutes for evaporation of any water to occur (you can go on to the next experiment while you are waiting). Hold the paper up to the light and compare your food substance to your positive and negative control. If you can see through the food substance, and there is an oily residue left on the paper like with the oil droplet, your food substance contains fat. Your water droplet should be virtually invisible because it should have evaporated leaving no residue behind. If your food item evaporates leaving no oily residue (like water), you can conclude that it has little to no fat in it. If you find it difficult to determine whether your food substance contains fat, wait 10 more minutes and allow both spots to dry further.

Experimental Data Sheet

**Food Item:**

**Testable Hypothesis (which macromolecules of life will be found?):**

**Experiment: Test for Fat**

<table>
<thead>
<tr>
<th>Drop #</th>
<th>Substance</th>
<th>Evaporation after 15 min?</th>
<th>Oily Residue after 15 min?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Neg Control</td>
<td>Distilled Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Pos Control</td>
<td>Oil Solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-Experiment</td>
<td>Your Food Item</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusion: ____________________________________________

**Experiment: Reagent #1**

**Testing For (circle one): Starch  Proteins  Sugar**

<table>
<thead>
<tr>
<th>Tube #</th>
<th>Substance</th>
<th>Reagent</th>
<th>Color of Reagent before mixing</th>
<th>Color after mixing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Neg Control</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Pos Control</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-Experiment</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusion: ____________________________________________
Experiment: Reagent #2

Testing For (circle one): Starch  Proteins  Sugar

<table>
<thead>
<tr>
<th>Tube #</th>
<th>Substance</th>
<th>Reagent</th>
<th>Color of Reagent before mixing</th>
<th>Color after boiling</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Conclusion: ________________________________________________________________

Experiment: Reagent #3

Testing For (circle one): Starch  Proteins  Sugar

<table>
<thead>
<tr>
<th>Tube #</th>
<th>Substance</th>
<th>Reagent</th>
<th>Color of Reagent before mixing</th>
<th>Color after mixing</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion: ________________________________________________________________

MACROMOLECULES I LAB WRITE UP:

1. SHOW YOUR RESULTS TO YOUR INSTRUCTOR BEFORE LEAVING

2. TURN IN QUESTIONS A-G BELOW USING BLACKBOARD

3. COMPLETE THE MACROMOLECULES II PRE-LAB AND BRING IT TO CLASS NEXT WEEK

A. What is the purpose of a negative control?
B. What is the purpose for sugar and starch in cells?
C. If you digested (broke) the polysaccharide starch into its monomers, which of the reagents would you use to test for proper digestion?
D. What two macromolecules did we not test for today? Do you believe that these are present in most foods? Why or why not?
E. Which food item did you test?
F. Which of the macromolecules of life were found in your food item?
G. Based on the background material in this lab and the material from class, would you consider this food item a good source of energy? Why or why not?
MACROMOLECULES II PRE-LAB
(DUE IN CLASS BEFORE THE BEGINNING OF THE MACROMOLECULES II LAB)

Choose three (3) food products that you would like to test for the presence of some of the macromolecules of life (proteins, sugars, starch, and fat). Be creative with your choices; however, your foods should be easy to get into a solution, and relatively clear colored (so that you can see the reaction in the background). Design experiments to test whether each of the three food products contains any or all of the following:

1. Proteins
2. Starch
3. Sugars
4. Fat

Resources you have available to you:

<table>
<thead>
<tr>
<th>Reagent #1</th>
<th>Starch solution</th>
<th>37 C incubator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reagent #2</td>
<td>Protein solution</td>
<td>Boiling water</td>
</tr>
<tr>
<td>Reagent #3</td>
<td>Strong sugar solution</td>
<td>Pancreatin</td>
</tr>
<tr>
<td>The Paper Towel Test</td>
<td>Weak sugar solution</td>
<td>Bile salts</td>
</tr>
<tr>
<td>Test tubes and racks</td>
<td>Fat solution</td>
<td>Mortar and Pestle</td>
</tr>
<tr>
<td>Wax pencils</td>
<td>Pipettes</td>
<td></td>
</tr>
<tr>
<td>Distilled water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Design your Experiment:**

Design tables, like the ones used in Macromolecules I, where you can record your data. You should be able to fill in all the columns except the “Color after mixing” and “Conclusion” column for your pre-lab exercise. Set up the tables and experiments in the most efficient way that you can. Be sure to write a hypothesis about which of the macromolecules of life you think you will find in each food item.

This will design will be graded in class before you begin the Macromolecules lab.
Macromolecules II Lab Write Up and Summary

Each individual in your group is responsible for completing this summary by oneself and turning in THEIR OWN Lab Summary. Although this was a group activity, every individual will receive a separate grade. See the syllabus for “a note on individual work.”

1. Which food items did you test?
   Food 1:
   Food 2:
   Food 3:

2. What was your hypothesis about the macromolecules that would be found in each of the food items?
   Food 1:
   Food 2:
   Food 3:

3. What macromolecules did you find in each of your food items?
   Food 1:
   Food 2:
   Food 3:

4. Was your hypothesis about each food item supported by your experiments?
   Food 1:
   Food 2:
   Food 3:

5. If your results were different than expected, explain any discrepancies.
   Food 1:
   Food 2:
   Food 3:

6. What further questions might you address related to this experiment? (At least one)

7. What further experiments could you do to answer these questions?

MACROMOLECULES II LAB WRITE-UP:

1. ANSWER QUESTIONS 1-7 IN THE COMMENT BOX ON BLACKBOARD

2. ASK YOUR INSTRUCTOR IF THEY WANT YOU TO ATTACH YOU’RE YOUR DATA TABLES TO THE ASSIGNMENT ON BLACKBOARD.
FIELD MUSEUM NATURAL SELECTION ACTIVITY

Objective: To see examples of natural selection first-hand, by viewing fossils of animals and plants that have existed through time.

Before you leave home:

Everything you need to know about visiting the Field Museum (hours of operation, directions, public transportation, etc.) is at www.fieldmuseum.org. Allow about 2 hours for your visit. Don’t forget to bring your lab book, paper for writing, a pencil or pen, and your student ID so that you can receive discounted admission. I suggest wearing comfortable shoes. There are two restaurants at the museum: Corner Bakery and McDonald’s. There is also an eating area on the lower level with vending machines where you can sit and eat a lunch you bring from home. It might be fun to visit the museum with a classmate!

Bring your student ID! Students are charged a discounted admission of $7.00. If you live in Chicago, and bring proof of Chicago residency such as a driver’s license, you will be admitted for $6.00. Chicago residents can also obtain a pass for free admission from any Chicago Public Library (go to http://www.chipublib.org/003cpl/partners/gkids/gkids.html for details). Remember to save your admission ticket- you must turn it in with the answers to activity questions as evidence of Field Museum attendance.

Take time to read about activities 1 - 4 on the following pages. Your will complete activities related to four exhibits: 1. Nature Walk, 2. North American Birds, 3. More about Sue, and 4. Evolving Planet. The exhibits are located on the north end of the main and upper levels. A museum map is included on the following pages.

Questions related to this activity that you are to answer: This activity has 6 questions to answer. They are labeled 1A, 1B, 2A, 2B, 4A, and 4B. (Note: part 3 of the activity doesn’t have any questions.) Your instructor may want you to submit your answers via Blackboard. Simply label your answers with the appropriate number and letter.

Importance of individual work: Each individual must complete his/her own handout and write answers to questions in his/her own words. That doesn’t mean that you can’t discuss questions and ideas with classmates who attend the museum with you- you certainly can. However, when it is time to write your answer, individual thought is required!
ACTIVITIES TO COMPLETE DURING FIELD TRIP

1. Observe different environments and adaptations of organisms to their environments. At “Nature Walk” (toward the north end of the main level, near the large dinosaur skeleton).

1A. Along the “Nature Walk” are several display cases of different types of environments (seashore, rocky mountaintop, forested woodland, prairie, pond, etc.) Select two display cases and describe how environmental conditions could differ. Some aspects to consider are below.
- How would physical characteristics such as temperature, wind speed, availability of sunlight or water, etc. differ between the two habitats?
- How does the land surface (proportion of soil, rocks, sand, etc.) differ between the two habitats?
- Vegetation can be a food source for animals as well as provide hiding places from predators. How does the type or amount of vegetation differ between the two habitats (tall or short trees, grass, a mixture, etc.)?

1B. Different traits are advantageous in different environments. For one of the environments in 1A above, describe two traits that would be advantageous for a plant or animal living in that environment. Do any of the plants and animals in the display case have these traits?

Be thorough in your answers and explain your thoughts. An easy way to answer this question is to let your imagination run wild! The following is an example of a thoughtful consideration of the “Ocean Shores” environment. As you walk under the “Nature Walk” sign from the main hall, you will see “Ocean Shores” to your right.

A. Water is shallow in the tide pool, so sunlight can easily penetrate to the bottom. Sunlight will heat the water, making temperatures warm during the day but cooler at night. Tides will also vary in a 24-hour period. The pool will be submerged by water during high tide but exposed to air during low tide. Organisms may be exposed to strong waves when weather is windy or stormy. At the bottom of the tide pool are large, heavy rocks that aren’t easily washed away by waves. A large portion of the rocks is covered by algae that could provide food or a hiding place for small organisms. Although water is abundant, it is salt water, so the organisms living within the tide pool must be adapted to living in salt water.

B. Examples of 3 traits that would be advantageous in the tide pool environment: 1) Because the pool is filled with water during high tide but dry during low tide, organisms must be able to survive in water as well as in air. The algae in the exhibit appear to have a tough, thick covering that could keep them from drying out in the sun. 2) An ability to attach to the rocks would help an organism avoid being washed to sea during strong waves. As explained by the exhibit placard, the algae attach to rocks with “holdfasts” at the base of their strands. Starfish attach themselves to the rocks via “suction cups” on their underside. 3) The pinchers on a motile organism such as a crab would help it catch prey, especially stationary prey attached to rocks.

As you walk through the exhibit, which shows 95% of all North American Bird species, note the great variety in beak shapes and sizes. Find the display case labeled “Ospreys,” “Kites,” “Accipiters,” “New World Vultures,” and “Harriers.” These predaceous birds tear open the flesh of their prey with short, pointed, curved beaks. Also, find the display labeled “Ibis and Spoonbills,” “Flamingos,” “Storks,” and “Heron and Bitterns.” Observe the flat, wide beak of the flamingo and read about how it is specialized for straining invertebrates from water. Other birds in this exhibit have beaks long enough to catch a fish underwater while wading.

Questions 2A and 2B refer to the shorebird display case, which is near the chairs and coffee table that you will see as you walk among the display cases.

2A. The “shorebirds eat what they can reach” diagram shows how different bird beaks are specialized to catch different types of invertebrates on a sandy beach. Some invertebrates hide under rocks, while others live in burrows that they dig to various depths in the sand.

Find the bird specimens (long-billed curlew, marbled godwit, etc.) in the display case. Describe how the sizes and shapes of their beaks allow them to exploit different food sources.

2B. Using at least two of the four tenets of natural selection (below), describe how natural selection could lead to the development of specialized beaks that allow a species to exploit a unique food source. When composing your answer, remember that competition for food can be fierce in the natural environment!

The four tenets of natural selection:

a) Individuals within a species vary greatly. Fur color, limb length, sense of smell, etc. are examples of traits that can vary.

b) More offspring are born than can survive. For example, a female rabbit has an average of 6 babies per litter. Because female rabbits can become pregnant again within hours of giving birth, they can have several litters per summer. If all of the offspring survived and reproduced, we would be overrun by rabbits within a few years. However, some are eaten by predators, some can’t find enough food, and others die due to a lack of other resources.

c) Competition exists between individuals. A rabbit with a keener sense of smell will be more likely to find a food source before another rabbit finds it.

d) Individuals with traits that confer an advantage in their environment are more likely to survive, reproduce, and pass those advantageous traits onto the next generation. Rabbits with a fur color that helps them blend into their environment are less visible to predators and will be more likely to survive and thus reproduce. The genes that code for that fur color can then be passed onto offspring.
3. Watch the 4-minute video called “Fact, Theory, or Speculation.” Head upstairs to the Upper Level and go to the hallway on the north side. Between the women’s and men’s restrooms is a small exhibit called “More on Sue.” There is a bench in front of television screens that alternates between showing two videos. Watch the video called “Fact, Theory, or Speculation.”

As you watch the video, note the difference between a fact, a scientific theory, and a speculation. You will use these definitions to answer a question related to the “Evolving Planet” exhibit.

A fact is an observation.  

Example of a fact: “Sue’s fibula (a leg bone) had abnormal growth.”

After many facts have been observed, a scientific theory may be developed to help explain the facts. The word “theory” is used differently in science than it is used in casual conversation. In casual conversation, we use the word “theory” when we aren’t sure of the facts. “Scientific theories,” on the other hand, are only developed after a great number of facts have been observed. A scientific theory is an explanation that ties facts together. Theories can be tested. If further observations show the theory to be false, the theory is either modified or falsified.  

Example of a scientific theory: “The abnormal growth of Sue’s fibula was caused by an injury when young.” Remember, an important characteristic of a scientific theory is that it can be tested and potentially falsified. If Sue’s fibula does not show evidence of bone healing, then the theory that the abnormal growth was caused by an injury could be modified or falsified.

A speculation differs from a scientific theory because it’s not possible to test a speculation.  

Example: In order for Sue to recover from severe bone injury, Tyrannosaurus rex dinosaurs must have taken care of their young. This statement is a speculation because we cannot test this statement with available facts. It’s not possible to observe dinosaur behavior. In the future, if a young, injured T. rex fossil was found with the fossil of its mother, it might provide evidence in support of this statement. For now, this statement is only speculation.

Facts are observations that lead to the development of scientific theories. Theories provide understanding about facts. Theories also lead to speculation and new observations!
4. The Evolving Planet exhibit consists of many rooms full of fossils of organisms that have existed since life began. Common favorites: the dinosaurs (in the Jurassic/Cretaceous room) and the gigantic extinct mammals (in the Quaternary rooms) such as the mastodons that lived in the Chicago area and the 12-foot tall short-faced bear. *As you leave “More on Sue,” walk down the hallway toward the men's restroom. “Evolving Planet” is located at the end of the hallway. A map showing the location of different rooms in the exhibit is on the last page of this handout.*

4A. Review the difference between fact, theory, and speculation. As you walk through the Evolving Planet exhibit, you will learn a lot of facts. Choose one fact, write it down, and write either a theory or speculation that could result from that fact. Remember that a theory can be tested and potentially falsified, while a speculation cannot be falsified with available facts.

If you choose to write a theory about your fact, explain how that theory might be tested and the potential results that would falsify the theory. If you choose to write a speculation about your fact, explain why the speculation could not be tested or falsified.

**Example:**

**Fact:** “The colorful petals of flowers attract pollinating insects in search of nectar. As the insects travel from flower to flower, they bring sperm-containing pollen from the male part of the flower (the stamen) to the female part (the carpel) of another flower. Without the help of pollinators, these flowering plants could not sexually reproduce.”

*You can learn this fact about flowering plants (also called angiosperms) from an exhibit in the Jurassic/Cretaceous room. The colorful exhibit explains the concepts and shows ancient fossils of flowering plants.*

**Scientific Theory:** “Flowering plants and pollinating insects evolved together, through coevolution.”

*Many flower and insect species living today are completely dependent upon one another. The insect is specialized to feed upon the nectar of only one type of flower. The flower, in turn, can only be pollinated by that insect. One cannot survive without the other! Coevolution is a scientific theory that explains how each of the partners could have become so specialized. You can learn about the evidence supporting the theory of coevolution from a movie next to the flowering plant exhibit. This scientific theory could be falsified. If studies of flowering plant/insect partnerships showed that each could thrive alone, then the theory would prove false.*

**Speculation:** “The evolution of new types of pollinating insects may have triggered the evolution of flowering plants.”

*This statement is based upon the fact that fossils of plants without flowers appeared in the fossil record 300 million years before the first flowering plants. It is a speculation because it cannot be falsified with available evidence. Currently, we have not found enough fossils to know whether pollinating insects triggered the evolution of flowering plants, or vice versa. Someday, someone might find evidence that could make this statement more than a speculation!*
It won’t be hard to find one fact in “Evolving Planet” about which you can write a theory or speculation! Simply choose a portion of the exhibit that looks interesting. Look at the fossils, read the placards, or watch one of the videos. Don’t forget write down the fact upon which your theory or speculation is based. Also, explain what makes your statement a theory or a speculation. In other words, explain how your theory could be tested and the potential results that would falsify the theory. If you choose to write a speculation, explain why it cannot be tested. See below for suggestions of different parts of the exhibit that you might visit to answer question 4A. You might also choose to write your answer about a part of the exhibit that isn’t described in the suggestions below.

4B. Last Question! In your opinion, what is the most unusual or fascinating ancient animal or plant you observed in the Evolving Planet exhibit? Describe the environment in which it lived. What traits (describe at least one) of this plant or animal made it well-adapted to its environment?

SOME IDEAS FOR COMPLETING QUESTION 4

The suggestions below describe different parts of the Evolving Planet exhibit that you might visit to answer question 4. See the map on the last page of this handout for the location of each room in the exhibit. Different rooms display fossils from different periods in earth’s history.

• One of the first exhibits in Evolving Planet, in the Precambrian rooms, is about asexual vs. sexual reproduction. There are a lot of facts, theories, and speculations about sexual reproduction and its importance to natural selection! You can also watch a short video that explains the concepts.

• The earliest land vertebrates and land plants are shown in the next section of the exhibit (Silurian/Devonian rooms). A lot of facts about these fossils are presented, as well as theories and speculations about how their adaptations allowed them to move onto land. (Before this time in the earth’s history, all life was aquatic.)

• Many of the fossils of plants and animals that lived during the Carboniferous period are from the Mazon Creek fossil deposit in Illinois (one of world’s the best fossil sites!). They include gigantic insects and invertebrates, including a millipede-like organism that was over 3 feet long. Illinois’ state fossil is the Tully Monster. Observe the Tully Monster or other fossils and write a theory or speculation about the kind of animal it is (e.g. worm, fish, mollusk, etc.). Remember that many aspects of plants and animals, such as soft tissues, color, behavior, etc. are usually not preserved in fossils.

• Watertight “amniotic” eggs (similar to a chicken egg with an outer shell, embryo, yolk sac, etc.) first appear in the fossil record during the Permian period. After viewing the exhibit about early egg development, think about why the evolution of this type of egg was so important to the success of early land vertebrates.
As you travel through the “Evolving Planet” exhibit, you will see descriptions of the six mass extinctions in earth’s history. What caused the different mass extinction events? How was climate during these times different than today? In the Triassic room is an exhibit that discusses why plants are usually more resilient than animals during mass extinctions. How do seeds play a role in the resilience of plants?

In the Triassic period, many different mammal groups existed and are known from tiny fossil teeth. How were these mammals similar (and different) to mammals that live today? View the fossils of early mammal teeth and write a theory or speculation about what teeth might tell us about diet, age, and in some cases, gender.

Most of the dinosaur skeletons are in the Jurassic/Cretaceous room. What is a dinosaur? Are dinosaurs alive today? (Hint: How are birds and dinosaurs related?) How did dinosaurs reproduce? Have baby dinosaurs been discovered?

As you leave the Jurassic/Cretaceous room, there is “movie” room with an easy-to-understand movie with facts, theories, and speculations about the mass extinctions of dinosaurs.

Examples of browsing and grazing mammals are in a large exhibit in the Tertiary rooms. What is the difference between browsing and grazing and how do the teeth of these animals differ from one another? There are many theories and speculations about why these differences exist.

When you are facing the large exhibit about browsing and grazing mammals, turn to the right to see an exhibit and video about convergent evolution. What is an example of convergent evolution? What is a theory that could explain why convergent evolution happens?

What do teeth tell us about the diets of extinct hominids? What were the main trends in tooth size and shape over time in the hominid family tree? How did Homo neanderthalensis (“Neanderthals”) differ from modern humans? Compare and contrast such features as body size, bone structure, facial features, cultural development, and tool use. Are there some anatomical structures in our bodies that aren’t useful anymore? (Hominid room)

Due to limited time, you weren’t asked to visit every part of the museum that relates to natural selection. If you can, I highly recommend visiting “What is an Animal?” on the main level. This exhibit shows many examples of natural selection, from how animals eat, move, and reproduce to how they protect themselves from predators. If you love animals or if you simply want to learn more about natural selection, you should definitely visit this exhibit. Plant lovers should visit “Plants of the World” on the upper level.
"Nature Walk" and "North American Birds" are on the north end of the Main Level.

"Fact, Theory, or Speculation" video is at the "More on Sue" exhibit in the hallway at the north end of the Upper Level.

"Evolving Planet" is also at the north end of the Upper Level.
Introduction

Permian

Carboniferous

Silurian/Devonian

Cambrian/Ordovician

Precambrian

Jurassic/Cretaceous

Tertiary

Hominids

Quaternary

Conclusions

Movie: What wiped out the dinosaurs?
**BIOL 100 (INTRODUCTION TO BIOLOGY) SYLLABUS, SPRING 2008**

**Dr. Jennifer Slate**  
Office Location: SCI 358-B  
Email Address: J-Slate@neiu.edu  
Telephone Number: 773-442-5734

Office hours: Mon. & Wed. 4:00 – 5:00 p.m.; Tues. 11:00 – 1:00 p.m.; and by appointment

**Lecture:** Both Sections 05 and 06 have lecture on Mon. & Wed., 1:00-1:50 p.m., in SCI-102.

**Lab:**  
Section 05 has lab on Mon., 2:00-3:50 p.m., in SCI-309.  
Section 06 has lab on Wed., 2:00-3:50 p.m., in SCI-309.

**Required Materials:**  
**Gloves:** Several labs during the semester will require you to wear disposable latex (or latex alternative) gloves.  
**Protective Eyewear:** You will be required to wear protective eyewear during laboratory sessions.

**Course Description:**  
This course meets the general education requirement for a science course with a lab. It is a 3-hour course with both lecture and laboratory components that addresses the fundamental issues and tenets of biology.

Before a typical lecture session you will be required to complete readings in the text and complete assignments on Blackboard based on those readings. During a typical lecture you will be expected to participate in class and small group discussions and take careful notes on information that is generated both in discussions and in instructor presentations.

In a lab, you will have the opportunity to design and conduct experiments, as well as to complete other activities that will help you better understand the fundamental tenets of biology. There is an assignment or practical exam related to each lab session, so it is necessary to participate in each lab session and to regularly check the schedule for due dates. There are several pre-lab quizzes throughout the semester that must be taken on Blackboard before the beginning of the laboratory session.

**GRADING (90-100% = A; 80-89% = B; 70-79% = C; 60-69% = D; <60% = F)**

<table>
<thead>
<tr>
<th>Lecture (600 points)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration on Blackboard by the second day of class.</td>
<td>2</td>
</tr>
<tr>
<td>3 exams at 150 points each. <em>The lowest exam score will be dropped at the end of the semester. No make-up exams will be given. If you miss an exam, the missed grade will be your dropped grade.</em></td>
<td>300</td>
</tr>
<tr>
<td>Final exam. <em>Some material will be new, but the remainder will be cumulative. The final cannot be dropped. Make-ups are allowed only in the case of a documented illness or emergency.</em></td>
<td>150</td>
</tr>
<tr>
<td>12 assignments at 4 points each. <em>These points will be awarded for each assignment that is completed on time (10 minutes before the start of lecture each week). 5 of these Assignments will be chosen at random to and graded in detail for 20 additional points each.</em></td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lab (400 points)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Lab Write Ups / Pre-lab Blackboard quizzes at 25 points each.</td>
<td>300</td>
</tr>
<tr>
<td>1 Practical exam on the fetal pig dissection.</td>
<td>50</td>
</tr>
<tr>
<td>1 Natural Selection assignment (based on in-lab activities or Field Museum field trip).</td>
<td>50</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1000</td>
</tr>
</tbody>
</table>
**Exams:** Exams will consist of short answer and/or multiple choice questions. The exams and quizzes will not only test whether you know the material, but your ability to use what you know to solve problems. In other words, you will be required to “think” rather than to simply “memorize,” and you must be able to relate different topics to one another.

**Assignments:** To help you regularly prepare for class, you will be required to complete a total of 12 assignments throughout the semester. These assignments will be based on required readings or in class discussions. Each assignment entry must be posted on Blackboard before the beginning of the day’s lecture session. You will receive 4 points for each assignment that is posted on time. Five randomly chosen assignments will be graded in detail throughout the semester for 20 additional points – late postings will not receive credit. The 5 dates may differ for different students. Your 20 point grade will be based on the following grading rubric:

- **20 points:** Thoughtful and complete response
- **18 points:** Good response, but lacked one key element
- **15 points:** Response was not as thoughtful as required
- **10 points:** Response didn't demonstrate an adequate understanding
- **4 points:** Response was incomplete and marginally acceptable
- **0 points:** Not submitted
- **-2 points:** Plagiarism or not citing a source when needed

**Lab Write Ups / Pre-lab quizzes:** There is a pre-lab quiz and / or post-lab write up related to every lab activity. See the course schedule for due dates. Pre-lab quizzes are open-book and must be taken on Blackboard before the beginning of the laboratory session. Pre-lab quizzes and lab write ups are each worth up to 25 points. Those points will generally be awarded according to the following rubric: “Superior” = 25 pts., “sufficient” = 18 pts., “insufficient” = 10 pts., and “absent or not submitted” = 0 pts.

**Attendance:** Attendance is mandatory for both lecture and laboratory sessions. During each lecture period, there will be a class discussion from which the instructor will develop exam questions. You will only be able to participate in the class discussion (and learn the material presented in the discussion) if you are present. You may also be required to complete assignment entries based upon the class discussion.

Laboratory experience is an essential part of this course and constitutes 40% of your final grade. If you must miss a laboratory session, it may be possible to attend another session if you make arrangements in advance. Otherwise, it is not possible to make up missed laboratory sessions.

**Required Reading Assignments:** Before each lecture period, you must complete the required reading assignment and related assignment entry. Completing the required reading will help you better understand material presented in lecture and lab and enable you to participate in small group discussions and laboratory exercises. In addition, regular reading (and regular studying) will make it easier to study for exams.

**Helpful Hints for Reading a Textbook:** (modified from www.oakton.edu/learn): Reading a textbook is a special skill and it is very different from reading a newspaper, magazine, or novel. When you read for your own pleasure, you may not have to retain details. Textbook reading is more difficult and you are expected to learn a considerable amount of material. By following the techniques below, you can save time and read more efficiently.

1. **Overview:** At the beginning of the semester, become familiar with the species features of your textbook. Skim the table of contents and check if there is an index and glossary.
2. **Preview:** To focus better on the significant points, preview your chapter before reading it. Read the chapter title, the interesting “facts” introduced on the first page of the chapter, and the chapter objectives. Skim through the chapter and read the subheadings. Finally, examine each diagram and read its caption. As you have probably heard, a picture is worth a thousand words. The text is often easier to understand after examining the diagrams.
3. **Questions:** Your textbook lists questions (called “Checkpoint”) at several points throughout the chapter. Before you read each chapter section, skim ahead to read the questions. Then, you will be able to focus on the essential information as you read. Even better: Make up your own questions before you read, by using key words, graphics, section headings, or topic sentences.
4. **Read:** Concentrating on the material is easier when you read to answer the questions in the text or the ones you formed. Also, depending upon how you learn best, underlining, highlighting, taking notes, making charts or flash cards, or reviewing aloud will help you remember what you have read and will save you time when you are studying for tests.

5. **Review:** One of the best investments of your time will be to review what you have read, either orally or by writing. By reviewing for a few minutes after reading, you will dramatically improve your retention. Experiment a little to find the strategy that works best for you. I like to stop reading at the end of each chapter section (or at the end of a group of paragraphs if the chapter section is long) and review the material by writing the key points in my own words. First, I close the text and try to write the key points as well as I can from memory. Then, I open the textbook and “fill in the blanks” by including the material I missed, still being careful to write in my own words. Another good strategy is to study with a partner and to take turns explaining concepts to one another.

A Note on Original Work: Students in this course are expected to adhere to the University Student Conduct Code (http://www.neiu.edu/~DeanSt/survival/conduct.pdf). We will all be working very closely together in class discussions and in the laboratory, where group efforts are a must. However, when individual efforts are called for–they must be accomplished alone. Assignment entries must be written in your own words. Even copying one sentence, without quote marks and a source reference, whether that sentence is from a book, article, or the internet, is plagiarism. *Any violation to the Code of Student Conduct (such as cheating or plagiarism) is grounds to fail the course. In addition, the violation will be referred to the Office of the Dean of Students and additional sanctions may be imposed by the university.*

**Withdrawing From the Course:** Students who wish to withdraw from the course must do so themselves through the Touchtone Telephone Registration System (TTRS). Neither faculty nor staff is able to withdraw a student from a course. In other words, students who simply stop coming to class but do not withdraw will receive a grade for the class that is based on (1) whatever work they did before they stopped attending and (2) the 0’s they receive for all work not done after they stopped attending. In almost all cases this works out to be a grade on “F”. **The final deadline for withdrawing from a class this semester is March 28, 2008.** Students withdrawing at that time will not receive any refunds. Withdrawals prior to that date may be eligible for refunds. Check the Schedule of Classes for a detailed listing of deadlines and refund policies.

**Incompletes:** The grade of “I” (Incomplete) will not be allowed except in circumstances clearly beyond the control of either the student or the instructor. A grade of “I” will not be given because of poor performance in the course.

**Tutoring:** A tutor is provided by the Biology Department for students who feel they need additional help. Contact information for the tutor and tutoring hours will be posted on Blackboard as soon as that information is available.
## BIO 100 COURSE OUTLINE

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture Topic</th>
<th>Assignment</th>
<th>Lab Topic</th>
<th>Lab Work DUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/7</td>
<td>Characteristics &amp; Chemistry of life Requirements for life, chemistry of water, and macromolecules</td>
<td>Assignment 1</td>
<td>Scientific method / Graphing Analyze anecdotes, case studies, and research studies</td>
<td>--</td>
</tr>
<tr>
<td>1/14</td>
<td>Macromolecules of Life More about macromolecules, Cell structure and function, Types of cells</td>
<td>Assignment 2</td>
<td>Microscope Fun! Bring in items from home to examine with light microscopes</td>
<td>Scientific Method Write-Up</td>
</tr>
<tr>
<td>1/21</td>
<td>Cell Structure, Energy and Enzymes , Cell structure and function, Thermodynamics</td>
<td>Assignment 3</td>
<td>Follow-up to Potato Lab: Scientific method and graphing, continued</td>
<td>Microscope Lab Write-Up</td>
</tr>
<tr>
<td>1/28</td>
<td>Energy and Enzymes continued Endothermic, Exothermic, Active transport, How enzymes make cells work</td>
<td>Assignment 4</td>
<td>Macromolecules-1 Determine which reagents detect macromolecules/interpret results</td>
<td>Blackboard quiz before lab begins</td>
</tr>
<tr>
<td>2/4</td>
<td>--</td>
<td>Assignment 5</td>
<td>In Class Enzyme Lab effect of pH on the rate of an enzymatic reaction</td>
<td>Macromolecule I Lab Write-Up AND Pre-Lab Due</td>
</tr>
<tr>
<td>2/11</td>
<td>Photosynthesis and Cellular Respiration Energy flow and cycling between producers and consumers</td>
<td>Assignment 6</td>
<td>Online Enzyme Lab Virtual investigation of enzymatic reactions</td>
<td>Macromolecule II Lab Write-Up</td>
</tr>
<tr>
<td>2/18</td>
<td>Digestion Food into energy and macromolecules of life</td>
<td>Assignment 7</td>
<td>Fetal Pig Dissection-1</td>
<td>Online Enzyme Lab Write-Up</td>
</tr>
<tr>
<td>2/25</td>
<td>Immune System Recognition and fighting of foreign particles</td>
<td>Assignment 8</td>
<td>Pig Practical</td>
<td>--</td>
</tr>
<tr>
<td>3/3</td>
<td>Exam 1</td>
<td>Assignment 9</td>
<td>Potato Lab and Osmosis Response of a biological organism (potato) to saline solutions</td>
<td>Kitchen DNA Write-Up</td>
</tr>
<tr>
<td>3/10</td>
<td>Major Control Systems (Nervous OR Endocrine System-Instructor’s choice)</td>
<td>Assignment 10</td>
<td>Pedigree Lab Use Pedigrees to explain inheritance</td>
<td>Potato Lab Write-Up</td>
</tr>
<tr>
<td>3/17</td>
<td>--</td>
<td>Assignment 11</td>
<td>Natural Selection-1 in lab OR Field Museum Trip Students will use beans to observe natural selection</td>
<td>Pedigree Lab Write-Up</td>
</tr>
<tr>
<td>3/24</td>
<td>Cellular basis for Inheritance DNA, RNA, protein, Information is passed through gametes</td>
<td>Assignment 12</td>
<td>Natural Selection-2 in lab OR Field Museum Trip</td>
<td>--</td>
</tr>
<tr>
<td>3/31</td>
<td>Genetics Meiosis / non-disjunction, Dominance, Co-Dominance, sex-linkage, Punnett Squares, Pedigrees</td>
<td>Assignment 13</td>
<td>Final Exam</td>
<td>Nat Selection write-up OR Field Museum Write-up</td>
</tr>
<tr>
<td>4/7</td>
<td>--</td>
<td>Assignment 14</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>4/14</td>
<td>Natural Selection The process and tenets of natural selection , How natural selection and evolution change populations</td>
<td>Assignment 15</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>4/21</td>
<td>Evolution Role of diversity, History of life, What was needed for life to begin and continue?</td>
<td>Assignment 16</td>
<td>Final Exam</td>
<td>--</td>
</tr>
<tr>
<td>4/28</td>
<td>Natural Selection &amp; Evolution, cont. The last lecture of the semester is Mon. Apr. 28.</td>
<td>Assignment 17</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

*Holidays (No Class): 1/21, 2/12, 3/17-3/23*
Possible Topics-Personal Projects for BIOL 104

Between September and November of this year you will be “overhauling” an area of your life in an effort to both understand and become sustainable in that area. Please choose one of the major topics based on the following guidelines

• This must be an area of your personal (home, work, school) life where you are currently not very sustainable.
• This must be an area of your personal life that you have the capability to change.
• This must be an area of your personal life that you are willing to explore and change.
• This should be something that you would be interested in learning about.

Major Topics:

1. **Garbage accumulation**: Possible subtopics - Composting, Waste Reduction, Re-using, Recycling, Hazardous Waste Disposal, others are acceptable if approved.

   - Citizens of the United States produce an average of 4 to 5 pounds of garbage per day. Take a close look at your personal garbage production. Without modifying your lifestyle in any way keep an honest journal of what you throw away for 2 days in a row. Write down everything that you throw into a trash can at home, work, school, or anywhere else.


   Read Garbage Land: On the Secret Trail of Trash by Elizabeth Royte.

   - Ask a local trash collector if you can interview them. Ask them what they think is the most common thing that Americans throw away. Ask them what they can tell about a person or family just based on their trash. Ask any other legitimate questions that time allows. If you are unable to interview a trash collector, take a quick walk around your neighborhood on collection day and take notes about what people’s garbage says about them. Please do not disturb the garbage in any way, just observe. These interviews should be a part of your final summary.

   - Write an update on your personal experience with this project. What are you learning about yourself? How have your habits related to garbage changed in the past month? Has this assignment impacted any other areas of your life to the point where you have made changes? Your thoughts should be incorporated into your presentation at some point.

2. **Use of Cleaning/Disinfecting products in the home**: Possible subtopics are acceptable if approved.

   - Take an inventory of all of the cleaning and disinfecting products that you actually use in your home. Run a quick search on each of them using this website or a similar one: [http://householdproducts.nlm.nih.gov](http://householdproducts.nlm.nih.gov). These websites give you “MSDS” or material safety data sheet information on each item that you use. Write down any surprising or disturbing information you find out about specific products that you use. What effects do these household cleaners have on your health as well as the environment?

   - Take a look at this website: [http://www.geocities.com/heartland/prairie/8088/clngrm.html](http://www.geocities.com/heartland/prairie/8088/clngrm.html) and determine if there are any household cleaning products that you would like to make for yourself. Choose one to replace something you are currently using. What are the benefits and disadvantages of using this product over the other? Have you noticed any difference in the cleaning capabilities? Have you noticed any health benefits with the use of this product?

   - Do some more research on one of the cleaners that you chose to replace with a more environmentally friendly or health friendly version. Find articles, research, and other
information about the ingredients in this cleaner that can be incorporated into your presentation. Summarize your findings for this assignment.

- Write an update on your personal experience with this project. What are you learning about yourself? How have your habits related to cleaning changed in the past month? Has this assignment impacted any other areas of your life to the point where you have made changes? Your thoughts should be incorporated into your presentation at some point. You should cite your sources in the presentation.

3. **Alternatives to disposable products**: Possible subtopics include - cloth diapering, use of “un-napkins” as an alternative to napkins, paper towels, baby wipes, toilet paper and Kleenex, use of non-disposable razor blades, use of non-disposable plates, cups, utensils, storage containers, Ziplocs, grocery bags, etc. other subtopics are acceptable if approved.

   - We have often been termed a “throw away society”. What does this mean to you? Take an inventory of all of the disposable products that you use in your home, at school, and at work. Without modifying your lifestyle in any way keep an honest journal of the disposables that you throw away for 2 days in a row. Make a detailed list of things that you could use to replace these disposable items.

   - Make a detailed list of things that you could use to replace the disposable items that you currently use. Pick two items from your list that you will use exclusively between now and the end of this project. What are the environmental benefits and disadvantages of using this product over the other?

   - Do some more research on one of the items that you chose to replace with a more “environmentally friendly” version. Find articles, research, and other information about the benefits and disadvantages of using this product over the disposable version. This data should be included in your presentation. Summarize your findings for this assignment.

   - Please write an update on your personal experience with this project. What are you learning about yourself? How have your habits related to disposable products changed in the past month? Has this assignment impacted any other areas of your life to the point where you have made changes? Your thoughts should be incorporated into your presentation at some point. You should cite your sources in the presentation.

4. **Energy Use**: Possible subtopics include – home energy audits and updates, reducing the use of gasoline (biking, bus riding, etc), reducing the use of natural gas (heating of the home, use of gas powered stoves), electrical energy reduction in the home, on campus energy grading, other subtopics are acceptable if approved.

   - Spend one entire day keeping a journal of your energy use. Be sure to specify the type of energy (electrical, crude oil “gasoline”, natural gas, bio power (wood etc) that you used and how long you used it. Take note of specific areas of energy use where you are wasteful and can improve.

   - With the help of your group, you should have chosen a subtopic under energy use. Write out your personal plan for optimizing this type of energy in your personal life.

   - Do some more research on the type of energy you have chosen to conserve, or the program that you have initiated personally. Find articles, research, and other information about the benefits and disadvantages of using (or reducing your use of) energy in this way. This data should be included in your presentation. Summarize your findings for this assignment. You should cite your sources in the presentation.

   - Write an update on your personal experience with this project. What are you learning about yourself? How have your habits related to energy changed in the past month? Has this
assignment impacted any other areas of your life to the point where you have made changes? Your thoughts should be incorporated into your presentation at some point.

5. **Water Use**: Possible subtopics include – personal water audit (home, school, work etc), water disposal of food, paper, and waste, other subtopics are acceptable if approved.

   - Spend one entire day keeping a journal of your water use. Be sure to specify where and when you are using the water and for how long it runs. Take note of specific times when you use water wastefully and can improve.

   - With the help of your group, you should have chosen a subtopic under water use. Write out your personal plan for optimizing your water use in your personal life (home, work, school, etc).

   - Why do we have to be so careful about our water use? Does water really ever get “used” or go away? Why would there be water shortages, and how does our use of water contribute to them? Think about how your personal use of water can lead to water pollution of any type. Do some research on the water cycle and water pollution if you need to. This data should be included in your presentation. Summarize your findings for this assignment. You should cite your sources in the presentation.

   - Write an update on your personal experience with this project. What are you learning about yourself? How have your habits related to water changed in the past month? Has this assignment impacted any other areas of your life to the point where you have made changes? Your thoughts should be incorporated into your presentation at some point.

6. **Food Consumption**: Possible subtopics include – Body for Life, food and grocery audit, fast food hunger strike, other subtopics are acceptable if approved.

   - Keep an honest journal of what you eat for two days. Do not change your habits at all. Be sure to specify what time of day you are eating as well. Take note of specific foods that you eat that produce a lot of waste (fast food for example).

   - With the help of your group, you should have chosen a subtopic under food consumption. Write out your personal plan for optimizing your food consumption (not only for the environment, but also for your health). Outline the food program you plan to follow from today until the end of this project and what environmental and health benefits you expect that program to produce. If you chose the Body for Life program, or a similar program, take a “before” picture. You may choose to show before and after pictures in your presentation, but it will not be required.

   - What types of changes have you seen in your health, body, and waste production in the last month? Be specific. How does being a good steward of our own bodies lead to our being a good steward of other things that have been entrusted to us? Draw a picture, paint, sculpt, write an essay or a poem, or find some other form of expression for your thoughts about this project so far. You may need to attach a file or a picture for this portion of the assignment. If you do, please tell me that you have done so. You may choose to incorporate this assignment into your final presentation.

   - Write an update on your personal experience with this project. What are you learning about yourself? How have your habits related to food consumption changed in the past month? Has this assignment impacted any other areas of your life to the point where you have made changes? Your thoughts should be incorporated into your presentation at some point.

7. **Alternatives to skin care products**: Replace commercial skin and body care products with those of 100% natural origin. Try to practice the principle of not using anything on your body that you cannot put inside your body (eat). Research and begin using alternatives for cosmetics, lotions, soaps, shampoo, hair sprays and gels, shaving cream, deodorant, toothpaste and mouth washes, perfumes, etc.
- Take an inventory of all of the items that you place on your skin, hair, scalp, teeth and gums. Search for each of these products using this website: http://www.cosmeticsdatabase.com. Be sure to use the name of the product as it appears on the packaging. This website grades each product based on a hazard scale (0-10). Read more about the ratings by clicking on their “about” and “faq” page. Write down any surprising or disturbing information you find out about specific products that you use. What effects do these products have on your health as well as the environment?

- Take a look at this website: http://www.geocities.com/Heartland/Prairie/8088/beauty.html (or any similar site) and determine if there are any skin care products that you would like to make for yourself. Choose one to replace something you are currently using. What are the benefits and disadvantages of using this product over the other? Have you noticed any difference in its capabilities? Have you noticed any health benefits with the use of this product?

- Do some more research on one of the products that you chose to replace with a more environmentally friendly or health friendly version. Find articles, research, and other information about the ingredients in this cleaner that can be incorporated into your presentation. Summarize your findings for this assignment.

- Write an update on your personal experience with this project. What are you learning about yourself? How have your skin care habits changed in the past month? Has this assignment impacted any other areas of your life to the point where you have made changes? Your thoughts should be incorporated into your presentation at some point. You should cite your sources in the presentation.
pH AND GRAPHING, BIO 201

NOTE: DUE TO THE TOXICITY OF REAGENTS USED IN TODAY’S LAB, GLOVES ARE REQUIRED!

Goals of today’s lab.
- Use a pH meter to measure pH changes after incrementally adding acid or base, and observe whether pH change corresponds with a color change.
- Graph your data, correctly graphing the independent and dependent variables.
- Use your knowledge of how buffers work to interpret patterns your data.

Background knowledge needed to conduct today’s lab.
- The pH scale is an inverse as well as a logarithmic scale (Ch. 3, textbook).
- How chemical buffers in a solution work to resist changes in pH (Ch. 3, textbook).
- The shape of a molecule corresponds with its function (Ch. 4, textbook).
- Chemical equations move toward equilibrium (Ch. 2, textbook).
- Independent vs. dependent variables in an experiment.

Introduction:

pH is an extremely important concept in biological systems. pH controls how we digest our food, how we breathe- even where plants and algae grow. The effects of pH can be seen everywhere from acid reflux to the problems caused by the recent increase in acidity in the earth’s oceans.

pH is the measure of the acidity or alkalinity of a solution. pH occurs because a small number of H₂O molecules will dissociate into H⁺ and OH⁻. In distilled water at 25°C, the concentration of H⁺ equals the concentration of hydroxide ions (OH⁻). This is defined as "neutral" and corresponds to a pH level of 7.0. Solutions in which the concentration of H⁺ exceeds that of OH⁻ have a pH value lower than 7.0 and are known as acids. Solutions in which OH⁻ exceeds H⁺ have a pH value greater than 7.0 and are known as bases. Examples of acidic and basic substances are given in Chapter 3 of your textbook.

It is important to remember that the pH scale is an inverse scale as well as a logarithmic scale. Because it is an inverse scale, the pH number increases as H⁺ concentration decreases. Accordingly, pH number decreases as H⁺ concentration increases. Because the pH scale is logarithmic, a change in one pH unit corresponds to a 10x difference in H⁺ concentration. A change in two pH units corresponds to a 10², or 100x difference in H⁺ concentration. For example, the H⁺ concentration in a solution of pH 9 is 10 times less than the H⁺ concentration in a solution of pH 8. The H⁺ concentration in a solution of pH 4 is 1000 times greater than the H⁺ concentration in a solution of pH 7.

The concentration of H⁺ has a large impact on the function of biological molecules. This is because function of a biological molecule is dependent upon its shape. A change in pH affects bonding within a molecule, changing its shape.

A buffer is a chemical that allows a solution to resist pH change. For example, human blood remains at pH 7.4, due to the H₂CO₃ (carbonic acid) buffer. If pH of human blood rises above 7.4 (H⁺ concentration decreases), then H₂CO₃ will dissociate into HCO₃⁻ and H⁺ until pH once again reaches 7.4. If pH of human blood falls below 7.4 (H⁺ concentration increases), the excess H⁺ will combine with HCO₃⁻, lowering the pH back to 7.4. See the chemical equilibrium equation below.

\[ \text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+ \]

After you measure changes in pH today, you will graph your data. To graph your data, you need to understand the difference between independent and dependent variables. The independent variable is the factor that you are directly changing to see what will happen. It is your experimental variable. The dependent variable is the factor that changes as a result of the independent variable. In other words, the dependent variable describes the results that you will measure.
Develop a hypothesis:
In your experiment today, you will begin with a pH buffer and adjust pH by 4 points in one direction. For example, if you start with pH 5, you would choose to either incrementally add base to gradually adjust pH to 9, or incrementally add acid to gradually adjust pH to 1.

Which pH buffer (4.0, 6.0, 8.0, or 10.0) do you select for your experiment? __________
Will you adjust pH 4 points higher or 4 points lower? ___________. At what pH do you expect to end the experiment? __________
Will you add acid or base to adjust pH to the desired value? ___________

Write a hypothesis (testable statement). Remember that you will begin with a buffer of a particular pH. Based upon your knowledge of buffers, what do you believe will occur when you add acid or base to that buffer. Write your hypothesis in the introduction section of your lab notebook.

Conduct the experiment:

1. Before you begin, make a table in the results section of your lab notebook in which you will record your data. First, you will choose whether you will add acid or base to the pH buffer, and the concentration of that acid or base (0.1 N or 1.0 N). When you conduct the experiment, you will incrementally add the acid or base 0.5 mL at a time. Each time you add an additional 0.5 mL of acid or base, you will record the pH and the color of the solution. You will add acid or base 0.5 mL at a time until you’ve added a total of 8 mL or until you’ve adjusted pH by 4 points- whichever comes first. See below for an example of a table to put in your lab notebook.

<table>
<thead>
<tr>
<th>Amount added (mL)*</th>
<th>pH</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial conditions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Record data in your lab notebook, not here.

*Specify if you’re adding acid or base, and the concentration of the acid or base (1.0 or 0.1 N).

Which of the columns in your table represents the independent variable, and which columns represent the dependent variables?

2. Using a graduated cylinder, measure about 50 mL of the pH buffer with which you will begin. Record the exact volume (48, 49 mL, etc.) in your lab notebook. Remember to look at the bottom of the meniscus when reading the exact volume.

3. Pour the buffer in a 100 mL beaker containing a small stir bar. Place the beaker on the stirrer, and turn the stirrer on so the solution is stirring slowly.

4. You will begin by measuring the initial pH of the buffer and recording the initial color. It’s important to measure the initial pH rather than simply trusting what is written on the bottle. Discuss the color with your lab partners and use your best judgment to determine the color (bright red, orange-red, etc.).

5. Now that you know the initial pH of your solution, make a note in your lab notebook of your target pH (either 4.0 points above or below the initial pH, depending upon whether you are adding acid or base).
6. Using a P-1000 micropipettor, carefully add 0.5 mL of the acid or base. (Be sure to properly set the P-1000 for 0.5 mL! Hint: 0.5 mL = _____ µl).

   Remember that once the micropipettor tip has become wet, you must make sure to hold the micropipettor vertical. If you are going to set the micropipettor down onto the table, you must first remove the tip.)

7. Record the color of the solution in the table in your lab notebook, and note whether you observed a color change.

8. Using the pH meter, measure the pH value and record in the table in your lab notebook.

9. REPEAT steps 6-8 until you’ve added a total of 8 mL of acid or base or until you reach the target pH.

10. Time permitting, repeat the experiment using the other concentration of acid or base. For example, if you had used 1.0 N base, you would now repeat the experiment with 0.1 N base.

Graph your data, in your lab notebook:

- What is the independent variable in this experiment? The independent variable is always graphed on the x-axis.
- What are the dependent variables in this experiment? A dependent variable is always graphed on the y-axis.
- Label each axis and include the unit in parentheses at the end of the axis label. An example of an axis label is “plant height (cm)” Note: pH does not have a unit.
- Compose a title for your figure. Make sure that your title completely describes figure contents. An example of an incomplete title is, “pH changes,” because the title is too vague. Be specific! Show your title to your instructor for feedback.
- Do you notice any patterns in your data? For example, does pH rise or lower continuously, or are there abrupt changes at any point?
- Label points of color change on your graph. Does color change correspond with (or not correspond with) any patterns in pH change?
- The instructor will ask each group to also graph their data onto an overhead, so that your data can be shared with the rest of the class during a class discussion.

Complete your lab notebook entry:

As you learned in BIO 150, a complete lab notebook entry has an introduction (in which you summarize the purpose of the lab in your own words and write the hypothesis), a methods section, results, and a discussion section.

In the discussion section, you will interpret the meaning of your data. Did your results support or refute your hypothesis? Why do you believe that you obtained those results? For example, remember that you added acid or base to a buffered solution. What effect might a buffer have on the ability of pH to change? Also, remember that the solution contained a pigment molecule that changes color if its shape changes considerably (the different shape causes the pigment to absorb and reflect different wavelengths of light). When pH of your solution changed abruptly, did the color of the solution also change? Could that color change be related to a change in the shape of the colored pigment molecules?

Good discussion sections also discuss the next step. For example, if the experiment were repeated, how would you improve it? Are there potential sources of error that you could eliminate? Would it be beneficial to change the methods (for example, add acid 0.2 mL at a time), and why? Or, do your results give you ideas for a completely new experiment? Would you change the independent or dependent variables? Write a new hypothesis that you think needs to be tested next.
GENERAL BIOLOGY I (LECTURE AND LAB)
BIO 201, Section 1, 4 credits, Spring 2009

Instructor: Dr. Jennifer Slate
E-mail: J-Slate@neiu.edu
Room 358-B (office)
Telephone: 773-442-5734

Office Hrs: Mon. & Wed. 2:00 – 3:00 p.m.; Thurs. 5:00 – 5:30 p.m.; Fri. 12:00 – 1:30 p.m.
Other appointments also available.

Class Meets: Mon. & Wed. 10:00 a.m. – 12:50 p.m., S-347

Textbook: Biology by Campbell, Reece and Mitchell, 8th edition or used copy of 7th edition.
Bring your textbook to each lecture, so that you can annotate figures we discuss.

Lab notebook: Official Lab Research Notebook (100 pages). Jones & Bartlett. (If you already purchased this lab notebook for BIO 150, you can use the same notebook for BIO 201.)

Gloves: Most labs during the semester will require you to wear disposable latex (or latex alternative) gloves. You are responsible for purchasing gloves and bringing them to each lab period. Gloves can be purchased at NEIU bookstore or at major retail stores such as Walgreen’s, Wal-Mart, etc.

Course Description: This first course of our introductory biology series focuses on the cellular aspects of biology, including: the basic structure of animal and plant cells; intracellular organelles; metabolic pathways; the cell cycle; and basic genetics. Laboratory exercises emphasize scientific method and writing, and include experience with basic techniques such as microscopy, biological assays, and gel electrophoresis. BIO 150 must be taken in the same semester or before taking BIO 201.

Required Reading: All of the material I present during lecture is explained thoroughly in the textbook. Have you ever had the experience of going to lecture and not understanding a word? That won’t happen if you read the required reading assignments in advance of lecture. If you are having trouble understanding the textbook, please talk with me about techniques for reading scientific textbooks. Because you must learn and remember the material that you read, reading a scientific textbook is requires different skills than reading a book or magazine. Once you master scientific reading skills, you will find it easier to succeed in your science courses.

Exam and Quiz Material: Exams and quizzes will be a mixture of multiple choice, short-answer, and essay questions. Exam questions will be comprehensive, meaning that you must understand how different topics relate to one another. The exams will not only test whether you know the material, but your ability to use what you know to solve problems. In other words, it won’t be sufficient to simply memorize— you must understand the underlying concepts.

Weekly Quizzes and Assignments: Regular studying is essential for success. Toward this goal, short quizzes and assignments will be given weekly. If you miss a quiz or in-class assignment due to absence or tardiness, you will forfeit your chance to obtain those points.
**Attendance and Punctuality:** It is crucial to attend every lecture and lab. For example, we will often discuss figures from the textbook. You will then be asked to interpret those figures on quizzes and exams, or to explain a concept by drawing a similar figure on your own. Students who miss lecture generally perform poorly on exams. In addition, the laboratory, quiz, and assignment portion of this course accounts for a significant number of points that can only be obtained if you are present.

**Make-ups & due dates.** Because labs require a coordination of a large number of people (lab prep staff, etc.), labs cannot be made up. If you know you must miss a lab, it may be possible (no guarantees) to attend another lab section if notification is given in advance. Make-ups for quizzes and exams will only be allowed in the case of an illness or other emergency that is documented (i.e. doctors note). Late assignments will be penalized 10% for each calendar day late.

**Preparation for Lab:** Laboratory exercises are complex and difficult to complete efficiently if you do not come to lab prepared. You are responsible for printing lab handouts posted on Blackboard, reading the handout before lab, and bringing the handout to lab.

**Scientific Writing:** Excellent writing skills are crucial to success in science and in almost any career. Writing is being emphasized more and more at NEIU. You will write a laboratory report that follows the standard scientific format, with an abstract, introduction, methods, results, and discussion, acknowledgements, and literature cited sections. You will also learn how to write in a lab notebook.

**Use of computers:** Knowledge of computer programs such as Word and Excel will help you complete assignments for this course. The Student Client Support Office has online tutorials at [http://www.neiu.edu/~scs](http://www.neiu.edu/~scs) (click on “Tutorials” on the left panel).

**Blackboard and NEIU e-mail address:** I will frequently post handouts, changes to the course schedule, your grades, etc. on Blackboard. I may also require that you turn in assignments through Blackboard. **It is your responsibility to regularly check Blackboard as well as your NEIU e-mail address.** According to NEIU policy, e-mail correspondence related to university business must be conducted through NEIU e-mail addresses.

To access Blackboard, login to NEIUport at [http://neiuport.neiu.edu](http://neiuport.neiu.edu) and click on the Blackboard link. If you have difficulty, bypass NEIUport by using the direct link to Blackboard, [http://neiu.blackboard.com/](http://neiu.blackboard.com/)

Login using the same NetID and password that you would use for NEIUport.

If you haven’t yet obtained a NEIUport NetID and password, you must do so.

1. Go to [http://neiuport.neiu.edu](http://neiuport.neiu.edu) and click on “Look up your NetID and Email address.”
2. If you don’t know your NetID, click on “Forget your NetID?”
3. Type your NetID into the box. Then click “What is my password?”
4. If you have problems, go to [http://www.neiu.edu/~scs](http://www.neiu.edu/~scs) for trouble-shooting tips or call the NEIUport help team at 773-442-4230.

**Trouble with Blackboard?**

1. Computer Services says that Blackboard works better with Internet Explorer than with other browsers. If you begin to have problems with Blackboard while using another browser, try downloading Internet Explorer.
2. AOL users: You can use AOL to connect to the internet, but don’t use the AOL browser with Blackboard. After you connect to the internet with AOL, open another internet browser.

**A Note on Original Work:** Students in this course are expected to adhere to the University Student Conduct Code ([http://www.neiu.edu/~DeanSt/survival/conduct.pdf](http://www.neiu.edu/~DeanSt/survival/conduct.pdf)). We will all be working very closely together in class discussions and in the laboratory, where group efforts are a must. However, when individual efforts are called for (exams, quizzes, assignments, lab reports, writing in your lab notebook, etc.) – they must be accomplished alone. Keep in mind that plagiarism is a serious offense. Even copying a phrase or sentence, without quote marks and a source reference, whether that phrase or sentence is from a lab partner, book, article, or the internet, is plagiarism. We will discuss plagiarism, and how to avoid it, in detail.
Please understand that it is never worthwhile to conduct an honor violation. Infractions are sad, because they show that a student doesn’t believe that he or she has the ability to perform well on one’s own. Dishonesty can ruin a career, so it is crucial to always have a habit of conducting honest work. *Any violation to the Code of Student Conduct (such as cheating or plagiarism) is grounds to fail the course. The violation will also be referred to the Office of the Dean of Students and additional sanctions may be imposed by the university.*

**GRADING**

<table>
<thead>
<tr>
<th>Range</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>450-500 pts. (90-100%)</td>
<td>A</td>
</tr>
<tr>
<td>400-449 pts. (80-89%)</td>
<td>B</td>
</tr>
<tr>
<td>350-399 pts. (70-79%)</td>
<td>C</td>
</tr>
<tr>
<td>300-349 pts. (60-69%)</td>
<td>D</td>
</tr>
<tr>
<td>&lt;300 pts.</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quizzes and Assignments</td>
<td>100</td>
</tr>
<tr>
<td>Exam 1</td>
<td>80</td>
</tr>
<tr>
<td>Exam 2</td>
<td>90</td>
</tr>
<tr>
<td>Cumulative Final Exam</td>
<td>110</td>
</tr>
<tr>
<td>Lab Activities / Lab Notebook</td>
<td>84</td>
</tr>
<tr>
<td>Lab Report &amp; Rewrite</td>
<td>36</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>500</strong></td>
</tr>
</tbody>
</table>

### BIO 201 SCHEDULE, SPRING 2009

<table>
<thead>
<tr>
<th>Week</th>
<th>Class</th>
<th>Topic</th>
<th>Ch</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lecture</td>
<td>Chemical foundations of biology; Properties of water; pH</td>
<td>2, 3</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Introduction to the scientific method and to graphing (independent vs. dependent variables, replicates, line and bar graphs). Study skills to succeed in BIO 201.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lecture</td>
<td>No Mon. lecture due to Martin Luther King day holiday</td>
<td></td>
</tr>
<tr>
<td>*Jan. 19-21</td>
<td>Lab</td>
<td>Learn to use micropipettors by testing hypotheses about the density of water &amp; other liquids. <strong>Bring your lab notebook to lab, and to every lab hereafter.</strong></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Lecture</td>
<td>Carbon and the molecular diversity of life. <strong>QUIZ 1 (chapters 2-3)</strong></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Graph data obtained when adjusting pH of buffered solution.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Lecture</td>
<td>Structure and function of macromolecules. <strong>READING AND NOTE-TAKING ASSIGNMENT DUE</strong></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Digest macromolecules (carbohydrates, proteins, and lipids) into monomers.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Lecture</td>
<td>The Cell. <strong>QUIZ 2 (chapters 4-5)</strong></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Use compound light microscope to distinguish prokaryotic and eukaryotic cells; use observations to understand the evolutionary theory of endosymbiosis; distinguish animal and plant cells.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Lecture</td>
<td>Membrane structure and function. <strong>EXAM 1 (chapters 2-6)</strong></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Movement of molecules through a membrane and the response of animal vs. plant cells to hypertonic, hypotonic, and isotonic solutions.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Lecture</td>
<td>Metabolism and enzymes</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Analyze activity of catechol oxidase when exposed to various temperatures or pH solutions. Examine the effect of an inhibitor (PTU) on the activity of the enzyme.</td>
<td></td>
</tr>
<tr>
<td>Week</td>
<td>Date</td>
<td>Lecture</td>
<td>Activity</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>8</td>
<td>Mar. 2-4</td>
<td>Lecture</td>
<td>Respiration. <strong>QUIZ 3 (chapters 7-8)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Introduction to hypothesis formation and experimental design. Student-designed fermentation experiment, week 1. Students work in groups to form a hypothesis about this question: Why is alcohol content of naturally aged wines between 12-14% alcohol, even though there may be sugar remaining in the growth mixture? Each group designs an appropriate protocol to test their hypothesis, and presents their protocol to the class.</td>
</tr>
<tr>
<td>9</td>
<td>Mar. 9-11</td>
<td>Lecture</td>
<td>Photosynthesis. <strong>QUIZ 4 (chapter 9)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Student-designed fermentation experiment, week 2. Students conduct the experiments designed during the previous lab. Lab reports will be written about this experiment, in the style of a scientific paper, with abstract, introduction, methods, results, discussion, and literature cited sections. Must include appropriate introductory background information from books or journal articles (no websites allowed).</td>
</tr>
<tr>
<td>10</td>
<td>Mar. 16-18</td>
<td>Lecture</td>
<td>Photosynthesis, cont. <strong>EXAM 2 (chapters 7-10)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Extract pigments from spinach and identify them with the spectrophotometer</td>
</tr>
</tbody>
</table>

**No class Mar. 23-28 due to Spring Break**

**Fri. Apr. 3 is the last day to drop Spring 2009 courses.**

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lecture</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Mar. 30 &amp; Apr 1</td>
<td>Lecture</td>
<td>Mitosis &amp; Meiosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Simulate mitosis &amp; meiosis, distinguishing the two processes. Examine mitotic cells in squash of onion root tip and/or in prepared slides with the microscope. <strong>LAB REPORT DUE</strong></td>
</tr>
<tr>
<td>12</td>
<td>Apr. 6-8</td>
<td>Lecture</td>
<td>Mendelian Inheritance. <strong>QUIZ 5 (chapters 12-13)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Writing workshop: Peer review of lab reports; improving writing skills.</td>
</tr>
<tr>
<td>13</td>
<td>Apr. 13-15</td>
<td>Lecture</td>
<td>Chromosomal basis of inheritance, sex linkage, etc. <strong>QUIZ 6 (chapter 14)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Online Fly Lab (different student groups are assigned different crosses).</td>
</tr>
<tr>
<td>14</td>
<td>Apr. 20-22</td>
<td>Lecture</td>
<td>Molecular basis of inheritance (DNA &amp; RNA). <strong>QUIZ 7 (chapter 15)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Chi square statistical analysis of data from last week’s online fly lab. View actual flies under microscope to see variation and appreciate that phenotype determination (e.g. eye color) is not always unambiguous. <strong>LAB REPORT REWRITE DUE</strong></td>
</tr>
<tr>
<td>15</td>
<td>Apr. 27-29</td>
<td>Lecture</td>
<td>From gene to protein. <strong>QUIZ 8 (chapter 16)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Restriction endonucleases; theory of gel electrophoresis; determine molecule size based on migration distance.</td>
</tr>
<tr>
<td>16</td>
<td>May 4</td>
<td>Lecture</td>
<td>From gene to protein, cont. <strong>QUIZ 9 (chapter 17)</strong></td>
</tr>
<tr>
<td>17</td>
<td>May 7</td>
<td>Final exam</td>
<td>CUMULATIVE FINAL EXAM. Thurs. May 7, 12:00-1:50 p.m.</td>
</tr>
</tbody>
</table>

*No classes Jan. 19 (Martin Luther King Day), Mar. 23-28 (Spring Break)
PROKARYOTIC AND EUKARYOTIC CELLS

Concepts to understand before beginning lab:
1. The structural differences between prokaryotic and eukaryotic cells (Chapter 6, textbook).
2. The structural differences between plant and animal cells (Chapter 6, textbook).
3. The Evolutionary Theory of Endosymbiosis (Chapter 25, textbook). Look up “endosymbiosis” in the index at the back of your textbook to find the specific page numbers.

Goals:
1. Determine whether live algal cells in pond water are prokaryotic or eukaryotic, based upon differences in cell structure viewed with the microscope.
2. Observe similarities between prokaryotic cells and the organelles in eukaryotic cells, and use those observations to understand how eukaryotic cells originated through endosymbiosis.
3. Observe and understand structural differences between plant and animal cells.
4. Proficiently sketch and label cells viewed with the microscope.

Introduction:
Every living organism belongs to one of the following three Domains: Bacteria, Archaea, or Eukarya. Bacteria and Archaea are single-celled organisms and the most primitive, with prokaryotic cells. All organisms that are not Bacteria or Archaea are classified in the domain Eukarya. Although Eukarya contains single-celled organisms as well as multi-celled organisms, all Eukarya are more advanced than Bacteria and Archaea because Eukarya have eukaryotic cells. (Note that but Eukarya and Archaea shared the most recent ancestor (Figure 1). Therefore, Archaea is more closely related to Eukarya than to Bacteria, even though Archaea and Bacteria both have prokaryotic cells.)

![Diagram of evolutionary relationships between Bacteria, Archaea, and Eukarya.](image)

Figure 1. Evolutionary relationships between Bacteria, Archaea, and Eukarya.

Prokaryotic cells (bacteria & archaea) are different than eukaryotic cells in two key ways that are observable under the microscope (Table 1). First, prokaryotic cells do not have organelles, while eukaryotic cells contain many membrane-bound organelles (nucleus, mitochondria, etc.). Second, because eukaryotic cells are highly compartmentalized, with different material separated into different organelles, eukaryotic cells tend to be larger than prokaryotic cells.
Table 1. Structural differences between prokaryotic and eukaryotic cells that can be observed with a microscope.

<table>
<thead>
<tr>
<th>Prokaryotic cells (Bacteria &amp; Archaea)</th>
<th>Eukaryotic cells (in all other living organisms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organelles are <strong>absent</strong>.</td>
<td>Organelles are <strong>present</strong>.</td>
</tr>
<tr>
<td>Tend to be <strong>smaller</strong> (diameter typically 1-10 μm).</td>
<td>Tend to be <strong>larger</strong> (diameter typically 10-100 μm).</td>
</tr>
</tbody>
</table>

Eukaryotic cells are thought to have evolved from prokaryotic cells through the process of endosymbiosis. **Endosymbiosis** is a beneficial relationship between two organisms, in which one organism lives within the tissues of another. For example, photosynthesizing algae live within sponges and coral. The sponges and coral benefit because they obtain products of photosynthesis from the algal “symbiont” that lives within their tissues. The algae benefit because they obtain nutrients and a safe living environment from their host.

The **evolutionary theory of endosymbiosis** posits that after millions of years of living together, the symbiont and host became so dependent upon one another that one could not survive without the other. Eventually, the genomes of the two organisms became intertwined, so that they became one organism. The “symbiont” became an organelle such as a mitochondrion or chloroplast, making the host cell eukaryotic. (See Figure 25.9 in your textbook, portions of which are reproduced below.)

![Figure 25.9](image-url)

Figure 25.9 (textbook). Mitochondria and chloroplast organelles were originally separate prokaryotic organisms. Over millions of years of evolution, most of the endosymbiont genome became incorporated into the genome of the host cell, making the endosymbiont an organelle rather than a distinct organism.

A multitude of evidence supports the evolutionary theory of endosymbiosis. You might be surprised to learn that not all of a eukaryotic cell’s DNA is held in the nucleus. Mitochondria and chloroplast organelles still retain some of their original DNA, and this DNA still resembles the DNA of the bacteria from which they originated. The DNA in mitochondria and chloroplast organelles is circular, like the DNA in bacteria. (DNA in nuclei is linear.) In addition, mitochondria and chloroplasts have their own DNA transcription and translation systems, including bacteria-like ribosomes. The phospholipids molecules that make up the membranes surrounding mitochondria and chloroplast organelles are also more similar to bacterial phospholipid molecules than to the phospholipid molecules that make up the outer membrane of a eukaryotic cell. You can read about more evidence for the evolutionary theory of endosymbiosis in chapter 25 of your textbook.
TODAY’S LAB ACTIVITY

You will write a complete lab notebook entry for exercises 1-3. Exercise 4 is a writing activity and will not be included in your lab notebook entry.

- The purpose of today’s lab is to make observations. You will use the compound light microscope to observe and distinguish prokaryotic and eukaryotic cells. You will also distinguish two types of eukaryotic cells (animals and plant) from one another. Finally, you will observe living organisms in pond water. Remember, making observations is the first step of the scientific method.
- As you describe your methods, be sure to specify the type of microscope you are using.
- In your results section, you will draw the cells as specified in exercises 1-3 and write observations about those cells. When you draw, you are allowed to use a pencil (an exception to the normal rule of using a pen.) Next to each drawing, always write the total magnification at which you are viewing the cell. Making careful drawings is an important part of the observation process. If you don’t make a careful drawing, you may overlook an important feature.
- In your discussion section, you are to write two hypotheses based upon the observations you made today. When you think about the characteristics of the cells you observe today, what scientific questions come to mind? If you could conduct any experiment possible, what hypotheses would you like to test? Use your imagination when you write the two hypotheses, but be sure to write the hypotheses as testable statements.

Exercise 1: Compare prokaryotic and eukaryotic cells.

To distinguish between prokaryotic and eukaryotic cells, you will compare prokaryotic algal cells to the eukaryotic cells of the Elodea plant. Prokaryotic algae are bacteria that have evolved the ability to photosynthesize. In fact, prokaryotic algae were the first photosynthesizers to evolve on Earth and the reason that the Earth’s atmosphere became oxygenated. Even today, photosynthesis by prokaryotic algae produces a large portion of the oxygen in the earth’s atmosphere. Eukaryotic plants are more advanced than prokaryotic algae and evolved later.

A. Make a wet mount of prokaryotic algae. Pipette a small drop of the blue-green colored prokaryotic algae onto a glass microscope slide, and cover with a cover slip.

B. Make a wet mount of an Elodea plant leaf. Tear one leaf from the plant, place on a glass microscope slide, and cover with a cover slip.

C. Observe and draw both types of cells at 450x total magnification. In the eukaryotic Elodea cells, draw and label the chloroplast organelles. In the prokaryotic cell, note the lack of organelles.

Note: It is important to observe and draw both types of cells at 450x total magnification. The prokaryotic are too small to be clearly visible at lower magnifications. Although the eukaryotic Elodea cells are much larger, they must also be observed and drawn at 450x magnification in order to accurately compare to the prokaryotic cell.

D. In addition to making drawings, write your observations in words. Compare the size and shape of the prokaryotic algal cells to the chloroplast organelles inside of the Elodea cells. Can you imagine that the chloroplasts in the eukaryotic Elodea cells could have originally been free-living prokaryotic algae?

Exercise 2: Compare two types of eukaryotic cells: plant and animal.

A. Make a wet mount of a cheek (animal) cell. Scrape the inside of your cheek with a toothpick, and smear onto a glass slide. Add a drop of methylene blue stain and cover with a cover slip.

B. Make a wet mount of a potato (plant) cell. Using a razor blade, cut a very thin section of potato. Add a drop of Lugol’s iodine (I2KI) stain, which tests for the presence of ________, concentrated in amyloplast organelles in the cells.
C. **Draw** the animal (cheek) cell, at both 100x and 450x total magnification. As always, specify the total magnification for each drawing.
   - Label the large organelle (nucleus) observed in each cell.
   - Note that the relatively amorphous, loose shape of the cell membrane (animal cells lack the rigid cell walls of plants).

D. **Draw** the plant (potato) cell, at both 100x and 450x total magnification. As always, specify the total magnification for each drawing.
   - Because you used Lugol’s stain, which turns a blue color in the presence of starch, the starch-containing amyloplast organelles will appear as a blue color. There can be several amyloplast organelles within each potato cell. **Draw and label** the amyloplast organelles.
   - Note that each potato cell is surrounded by a rigid cell walls (unlike the cheek cell). Label the cell walls on the potato cell.

**Exercise 3: Observe microscopic organisms in pond water.**

A. To make a wet mount of pond water, obtain a drop of material *that has settled to the bottom of the jar* and place on a microscope slide. Cover with a cover slip.

B. **Draw** any living organism that you find interesting. Be sure to specify the total magnification at which you are observing the organism in your lab notebook.

C. **Challenge:** try to find examples of both prokaryotic and eukaryotic cells in the pond water! Show what you find to your instructor.

**Exercise 4: Endosymbiosis assignment** *(Note: this writing activity is to be completed separately- it is not part of your lab notebook entry.)*

**Assignment Instructions**

An explanation is about to take a biology exam, but is confused about the Evolutionary Theory of Endosymbiosis. Explain the concept to your friend so that she can understand!

**In your explanation, include**

A. An example of a modern endosymbiotic relationship. What benefit does each organism in the relationship provide to the other?

B. After billions of years of evolving together, could the two organisms that you described in part A theoretically become dependent upon each other, each unable to live on its own? Use your imagination and think of a function that one of the organisms might lose the ability to perform, becoming dependent upon the other organism to perform that function.

C. Use the examples you gave in parts A and B to explain how mitochondria and chloroplast organelles could have originated according to the Evolutionary Theory of Endosymbiosis.

D. Read p. 516-517 in textbook, 8th edition. (Look up “endosymbiosis” in the index at the back of your textbook to find page # for previous editions). Tell your friend about two pieces of evidence described in those pages that support the theory that mitochondria and chloroplast organelles were once separate prokaryotic organisms.

E. Ask a friend or family member who is *not in this class* to read your explanation. If that person can clearly understand your explanation, then you’ve done a great job! (In general, if a person has to read a sentence or paragraph twice in order to understand, it often means that the passage could be written more clearly. Ask the person reading your explanation to circle sentences that they had to read twice.) **Write a two-sentence summary** about that person’s comments about your explanation. **Explain how you modified** your explanation based upon that person’s comments.

**Grading:**

3 pts.: Parts A-E fully addressed; explanation is in clear, simple language that a non-expert can understand.

2 pts.: Parts A-E fully addressed, but some of explanation is not in clear (your friend is still confused).

1 pt.: Parts A-E fully addressed, but much of explanation is not clear (your friend is still really confused).

0 pts.: Incorrect information (misunderstanding of concepts).
FERMENTATION OF ALCOHOL, BIO 201

Goals:

**Week 1:**
- Measure CO$_2$ evolved during alcohol fermentation at different yeast concentrations.
- Develop a hypothesis about a factor that affects yeast fermentation.
- Design an appropriate protocol to test your hypothesis.

**Week 2:**
- Conduct your experimental protocol.
- Create a graph of your results.
- Interpret your results
- Understand how to write your results in the format of a primary research paper, with abstract, introduction, methods, results, and discussion sections.

Topics to understand before you begin:
- The difference between aerobic cellular respiration and alcohol fermentation (Chapter 9, textbook).
- Enzymes perform best under optimal conditions. Each enzyme has an optimal pH, temperature, salt concentration, etc. (Chapter 8, textbook).

INTRODUCTION

Yeast can conduct alcohol fermentation.

Yeast (*Saccharomyces cerevisiae*) is a single-celled fungus. You may be familiar with yeast if you have baked bread from scratch or brewed beer or wine. Yeast is a facultative anaerobe, meaning that it can produce ATP via aerobic or anaerobic processes. When oxygen is present, yeast conducts aerobic cellular respiration. When oxygen is absent, yeast conducts anaerobic fermentation.

When yeast conduct anaerobic fermentation, they produce alcohol as a byproduct. (This is in contrast to lactic acid fermentation, conducted in your muscle cells when oxygen is absent, in which lactic acid is produced as a byproduct.) The equation for alcohol fermentation is

$$C_6H_{12}O_6 \rightarrow 2C_2H_6O \text{ (ethanol)} + 2CO_2 + \text{energy (ATP)}$$

Note that glucose is broken down to produce ethanol (a type of alcohol) and carbon dioxide. Because the reaction is catabolic, it releases energy, and that energy is used to phosphorylate ADP to ATP, via substrate-level phosphorylation.

Why does alcohol fermentation by yeast stop once alcohol content reaches 12-14%?

When yeast is used to produce wine or beer, the yeast can only naturally produce an alcohol content of 12-14%. In other words, even when sugar still remains in the growth medium, yeast stop catabolizing that sugar once alcohol content reaches 12-14%. Why do you think that this occurs? What factors do you think can affect fermentation by yeast? You will design and conduct an experiment in which you will examine a factor that can affect alcohol fermentation.
FERMENTATION WEEK 1

During the first half of lab, you will become familiar with the protocol used to measure CO₂ evolved during alcohol fermentation at different yeast concentrations. During the second half of lab, you will develop a hypothesis about a factor that can affect alcohol fermentation, and design an appropriate protocol to use next week to test that hypothesis.

A. Measure CO₂ evolved during alcohol fermentation at different yeast concentrations. Be sure to write a complete lab notebook entry for part A, with introduction, methods, results, and discussion.

Protocol:

1. Prepare the test tubes.
   a. Add solutions to tubes labeled 1, 2, 3, and 4, as in the table below. Rotate each tube to distribute the yeast evenly in the tube. Which tubes are the control tubes?
   b. Place the test tubes in a test tube rack in a warm water bath. Record the temperature of the water bath in your lab notebook. Allow the test tubes to equilibrate in the water bath for about 5 min.

<table>
<thead>
<tr>
<th>Tube #</th>
<th>DI water (mL)</th>
<th>Yeast suspension (mL)</th>
<th>10% Glucose solution (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

2. During the 5-min. wait period, practice building a Respirometer.
   a. Attach a piece of plastic aquarium tubing to a 1-mL graduated pipette, and place in a test tube filled about half-way with water.
   b. Use the pipette pump to draw the liquid from the test tube into the graduate pipette. Fill the graduated pipette to slightly above the 0-mL calibration line.
   c. Remove the pipette pump, quickly placing your finger over the open end of the aquarium tubing, to stop the liquid in the graduated pipette from falling back down into the tube. Fold over the aquarium tubing and clamp it shut with a binder clip.
   d. Open the clip slightly, and allow the solution to drain down to about the 0-mL calibration line. Don’t try to drain the solution to exactly the 0-mL calibration line. Just get fairly close (within about 1 mL above or below the 0-mL calibration line) and record the exact value as your initial reading (I).
3. **After the 5-min. wait period has passed, make a respirometer in each test tube.**
   
a. In each test tube, place a 1-mL graduated pipette to which a piece of plastic aquarium tubing has been attached. Use the graduated pipette to stir the liquid, so that the solutions are mixed.

b. Starting with one test tube, use a pipette pump to draw the liquid from the test tube to slightly above the 0-mL calibration line in the graduated pipette. As you practiced in #2 above, clamp the aquarium tubing, and then release the clamp so that the level of liquid drops to near the 0-mL calibration line. Quickly do the same for the other 3 pipettes.

c. *In a table in your lab notebook, quickly* record the exact level of liquid in the graduated pipette in each test tube. This level is called the Initial (I) value. Record this value in the first row of column A for each test tube (see table below). Write the time that you recorded this initial data.

d. Return the test tube rack with the test tubes to the water bath. Record the temperature of the water bath in your lab notebook.

e. Every 2 min. thereafter, observe the level of the liquid in the graduated pipette in each of the 4 test tubes, and record in column A. *If CO₂ is being evolved, the accumulation of CO₂ at the top of the graduated pipette will push down the level of liquid. Record the level of liquid every two minutes, until 20 min. is reached.*

f. In column B for each test tube, you will calculate the amount of CO₂ that has evolved during each 2-min. interval. Subtract the initial value (level of liquid at time 0) from each value in column A.

---

**Example of a table to put in your lab notebook:**

<table>
<thead>
<tr>
<th></th>
<th>TUBE 1</th>
<th></th>
<th>TUBE 2</th>
<th></th>
<th>TUBE 3</th>
<th></th>
<th>TUBE 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Column A</td>
<td>Column B</td>
<td>Column A</td>
<td>Column B</td>
<td>Column A</td>
<td>Column B</td>
<td>Column A</td>
</tr>
<tr>
<td>Time (min.)</td>
<td>Level of liquid (mL)</td>
<td>CO₂ evolved (A - I)</td>
<td>Level of liquid (mL)</td>
<td>CO₂ evolved (A - I)</td>
<td>Level of liquid (mL)</td>
<td>CO₂ evolved (A - I)</td>
<td>Level of liquid (mL)</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
</tr>
<tr>
<td>etc… (every 2 min., for total of 20 min.)</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
<td>A - I</td>
<td>A</td>
</tr>
</tbody>
</table>
B. Develop a hypothesis with your group about a factor that could affect alcohol fermentation by yeast. Before you proceed to part C, ask your instructor to give feedback about your group’s hypothesis.

Your goal is to obtain data that will help answer the following question: Why do naturally-aged wines have an alcohol content of only 12-14%, even when sugar remains in the growth medium?

The following equipment and solutions will be available.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment to build respirometers.</td>
<td>Water baths of various temperatures</td>
</tr>
<tr>
<td>Test tubes &amp; racks</td>
<td>Various types of sugar (glucose, fructose, sucrose, etc.).</td>
</tr>
<tr>
<td>Labeling materials</td>
<td>Various pH buffers</td>
</tr>
<tr>
<td>Assorted beakers</td>
<td>Salt</td>
</tr>
<tr>
<td>Graduated cylinders</td>
<td>Distilled water.</td>
</tr>
<tr>
<td>Micropipettes and tips</td>
<td>50% ethanol</td>
</tr>
<tr>
<td>Activated yeast culture</td>
<td></td>
</tr>
</tbody>
</table>

C. Design an appropriate protocol to test your hypothesis. Write the following information on an overhead, so that each group’s experimental protocol can be discussed as a class.

- Your group’s hypothesis.
- Equipment/solutions you will need.
- A table that shows the amount of each solution that you will put in each test tube. Note that each test tube should contain an equal volume of liquid (as in the table on p. 2 of handout).
- Your predicted results (in which tube do you expect to see the most CO$_2$ evolved, and why)?

D. Begin your lab notebook entry for next week. Write the following in your lab notebook before lab. When you have prepared in this way, the lab will run more smoothly. During the lab, if you need to add to or change your entry, you may.

- Compose a title for your experiment.
- Introduction, including
  - Your hypothesis, and the scientific reasons for your hypothesis (what scientific information led you to develop your hypothesis)?
  - Your predicted results (in which tube do you expect to see the most CO$_2$ evolved, and why)?
- Methods, including
  - Equipment/solutions, and how you will use those solutions and pieces of equipment.
  - A table of the amount of each solution that you will put in each test tube.
- Table in which you will record your results.
FERMENTATION WEEK 2

A. Test your group’s hypothesis by carrying out the experiment you designed last week. As you carry out your experiment today, complete your lab notebook entry, with introduction, methods, results, and discussion sections.

B. After you obtain your data, graph CO$_2$ evolved over time. Follow these instructions. Note: these instructions are for using Excel 2003. If you have Excel 2007, which is installed on newer computers that have the Vista operating system, then the steps for making graphs may be slightly different.

1. Input your data into an excel spreadsheet, with time in the first column. Put a clear label at the top of each column. See the example below.

<table>
<thead>
<tr>
<th>Time (min.)</th>
<th>Control- no yeast</th>
<th>Control- no sugar</th>
<th>2 mL yeast</th>
<th>4 mL yeast</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.01</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>4</td>
<td>0.01</td>
<td>0</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>etc.</td>
<td>etc.</td>
<td>etc.</td>
<td>etc.</td>
<td>etc.</td>
</tr>
</tbody>
</table>

2. Highlight all cells, including the data and the labels at the top of each data column.
3. Click on “Insert,” then “Chart.” Choose “XY (Scatter)” and then highlight the bottom-left graph (the scatter with data points connected by straight lines).
4. Click “Next” two times to reach the Titles tab.
5. In the “Value (X) axis” box, type “Time (min.)”
6. In the “Value (Y) axis” box, type “CO$_2$ evolved (mL)”
7. Click Finish.
8. Click on the Y-axis label and highlight the “2” of “CO2.” Right-click on the “2” while it is highlighted. In the “Format Axis Title” box, check the “Subscript” box. This will make the 2 of CO2 a subscript.
9. You can insert your graph into your lab report by clicking on it and copying and pasting the graph into a Word document.

C. Write the following on an overhead and obtain feedback about your data during a class discussion.

1. Rewrite your hypothesis as a research objective. (Refer to the last sentence of the introduction section in the horseshoe crab paper as an example.)
2. Briefly describe several pieces of information that you and your group feel should be included in an introduction section. (What background information is crucial for understanding the research objective?)
3. Summarize the “main gist” of your results in one sentence.
4. Did the data support or refute your hypothesis? Give a scientific explanation for your data.

D. Obtain instructions for writing your lab reports.

The data you obtain will be the basis for the formal lab report you will write this semester. The lab report will be in the style of a scientific paper, with an abstract, introduction, methods, results, and discussion, acknowledgments, and literature cited sections. Each student is responsible for writing his/her own lab report. Although you worked in groups to obtain the data, you write the lab reports individually.
LAB REPORT ASSIGNMENT, BIO 201

• Write a lab report in the style of a scientific paper, with the following sections.
  – Abstract, Introduction, Methods, Results, Discussion, Acknowledgements, Literature cited

DUE DATE: WED. APR. 1. Grades will be penalized 10% for each day that the lab report is late.

Turn in: 1) A printed copy of your lab report and 2) the completed lab report checklist.

Important note: Although you worked in groups to obtain your data, your lab report must be written individually. Feel free to discuss your data with your labmates or with anyone in the class. However, when it comes time to write, you must do the writing on your own.

Resources
- A summary of what to include in each section of your lab report is below.
- Read Chapters 3 and 4 in Writing Papers in the Biological Sciences, by McMillan, for more thorough information about what to include in each section. (A copy is available on reserve in the reference section of the library.)
- Re-read the horseshoe crab research paper as an example.
- Complete the “Lab Report Checklist” to make sure that you haven’t forgotten anything important.

Meeting with me about your lab report
- You may meet with me in my office hours (or make an appointment outside of office hours) to discuss your lab report before the due date. This would be a great advantage to you, because I will give you feedback so that you can revise your lab report before it is graded. Students who take advantage of this opportunity tend to complete much better lab reports!

The “audience” for your paper
• Assume that the reader is a college student who has not yet taken General Biology. (You, before you began this class!)
• Any information that you didn’t already know before beginning this class must be supported by a citation. It cannot be assumed to be “general knowledge.”

Title
• Be specific- include the factor that you varied and the organism that conducted the fermentation.
• Example: Why is the following title insufficient? “Effect on Fermentation?”

Abstract
• Even though it appears at the beginning of a research paper, it is written last!
• Abstract should summarize introduction, methods, results, and discussion sections. (1-3 sentences summarizing each section.)

Introduction section
• Background information necessary to understand the research topic
  – You can obtain all necessary background information from the textbook, so you may cite the textbook.
  – You’re welcome to cite other scientific books, but websites cannot be cited.
• Justification of the necessity of the research
• Ends with a statement of research objectives.
Think carefully about the background information to include in Introduction

• Think about what the reader needs to know.
• Example: You measured CO₂
  — Do you think you should include background information about how CO₂ is related to fermentation?
• What specific background info is necessary to understand your specific research objective?

Methods section

• Description of the methods and equipment, so that
  — readers understand how the research objectives were tested
  — someone else could repeat the research.
• Note that the methods section in a formal paper is often less detailed than your lab notebook.
  — Refer to the methods section in the horseshoe crab paper. How detailed was that methods section?
• You may find that including a table in your methods section makes it easier to describe your methods.

Results section

• Present the research results
  — without discussing what the results mean
• Present data in graph format, with a figure caption at the bottom of the graph. The graph should be “stand alone,” meaning information necessary to understand the graph (e.g. units) is included in the graph or figure caption— it shouldn’t be necessary to refer back to the text of the paper to understand the graph.
• Be sure to summarize content of graph in the text of the results section. The reader should be able to understand the “main gist” of the table’s data simply by reading the text in the results section.

Discussion section

• Should be the longest section in your paper.
• Gives a scientific explanation for the data.
• Discusses problems or potential limitations of the current research study.
• Compares the data to other scientific studies.
  — For this assignment, instead of comparing your data to previously published research, you will compare your data to the data of at least 2 other groups in this class. See Blackboard for graphs of data obtained by other students!
• Gives conclusions, or summarizes the implications of the results.
• Suggestions for future research studies, based on the data you obtained.

Acknowledgements section

• Thank those who
  — provided equipment or facilities (NEIU Biology Department)
  — helped with planning the research, collecting data, etc. (your lab mates)
  — read drafts of the article and made suggestions for improvement

Literature Cited section

• Use correct format within the text of your paper, when you cite a source such as your textbook and in the literature cited section (see the horseshoe crab paper as an example).
Avoid common pitfalls

• See the Checklist posted on Blackboard.
• You will turn in the checklist along with your lab report!

Grammar and Style

• Begin each paragraph with a topic sentence. (If the reader read only the first sentence of each paragraph, he should obtain a summary of report contents.)
• If a sentence does not relate to the topic sentence, it does not belong in the paragraph.
  —You might need to separate some paragraphs with different ideas into two different paragraphs.
• Break up long sentences. In general, if a sentence is more than 3 lines long, or has more than 2 commas, break it up.

Importance of Proper Grammar

• If you struggle with grammar, you really want to improve it because it will impact your ability to get a good job.
• This is especially true if English is your second language.
• The writing lab on campus is very helpful (773-442-5480)! Bring this assignment sheet, the checklist, and all other relevant materials to your appointment.

Good ways to catch grammar mistakes

• Read your paper out loud.
• Read your paper backwards.
• Set your paper aside and read it the next day.
• Ask someone else to proofread your paper!

Scientific names

• Italicize or underline scientific names: Saccharomyces cerevisiae (baker’s yeast).
  (Genus name is Saccharomyces; Species name is cerevisiae.)
• Genus names are capitalized, species names are not.

How to use subscript or superscript

• In Microsoft Word, highlight the text you want to appear above or below the line. Choose Format, then Font, then check the subscript or superscript box. Examples: CO$_2$, NAD$^+$

Don’t plagiarize!

• If you don’t site the source of scientific information (e.g. in the introduction) when paraphrasing, you are plagiarizing. If you also include scientific information in the discussion section, cite the source!
• Put the author’s name(s) and year of publication in parentheses, at the end of appropriately paraphrased sentences or paragraphs.
• If even one sentence or long phrase is copied from any source, you are committing plagiarism, whether that source is your textbook, the internet, or another student. Don’t do it- the sanctions are severe!
• If you have any question about what constitutes plagiarism- ask!
• (If a copied sentence or phrase is in quotes, then it’s not plagiarism. However, direct quotations are rarely used in scientific papers. Instead, the information is paraphrased.)
Course description:
In this second course of our introductory biology series we introduce the diversity of life in the context of evolutionary theory, studying biological processes at levels of organization ranging from populations to ecosystems. Laboratory exercises emphasize scientific method, writing, and include surveys of major groups of organisms.

On successful completion of this course you will have the understanding of biological principles, techniques, and communication methods to be successful in the other biology core courses and in many biology electives (see the NEIU catalogue for details).

Prerequisites: Bio 201 and passing score on ECE
Prerequisite or co-requisite: Bio 150

Course meetings and locations:
Lecture: Tuesday and Thursday, 9:25-10:40, B-146
   Section 01 Lab: Tuesdays, 10:50-1:30, S-308
   Section 02 Lab: Thursdays, 10:50-1:30, S-308

Instructor information:
Instructor: Kara Nuss  
E-mail: K-Nuss@neiu.edu  
Office location: S-352A  
Phone: 773-442-5225  
Office hours: Tuesdays 2:00 – 3:30, Wednesdays 10:00 – 1:30, or by appointment

**You must use your NEIU e-mail account for all e-mail communication**

Textbook:

Required laboratory supplies:
Note: You can use a notebook from a previous class if it is more then half empty.

Latex gloves
Dissection kit

Assignments:
If, on receiving your graded work you believe that I’ve made an error, you must bring your concern to my attention within one week. I will not reconsider the assigned grade after one week.

For full credit, assignments must be turned in by the designated time and date. If an assignment is turned in within 24 hours after a due date, 20% of points will be deducted. An additional 20% of points will be deducted for every additional day that an assignment is turned in late. No assignments will be accepted after the final exam.
General Biology II
Bio 202 – Spring 2010

Grading:

<table>
<thead>
<tr>
<th>Item</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Selection Lab</td>
<td>15</td>
</tr>
<tr>
<td>Earth History Activity</td>
<td>5</td>
</tr>
<tr>
<td>Ecology Poster</td>
<td>25</td>
</tr>
<tr>
<td>Climate Change Activity</td>
<td>5</td>
</tr>
<tr>
<td>Field Museum Activity</td>
<td>25</td>
</tr>
<tr>
<td>Bacteria Lab (2 weeks)</td>
<td>15</td>
</tr>
<tr>
<td>Plant Lab (2 weeks)</td>
<td>15</td>
</tr>
<tr>
<td>Worm Dissection Questions</td>
<td>10</td>
</tr>
<tr>
<td>Lab Notebook Check</td>
<td>10</td>
</tr>
<tr>
<td>Animal Anatomy Paper</td>
<td>60</td>
</tr>
<tr>
<td>First draft (20 points)</td>
<td></td>
</tr>
<tr>
<td>Critique (10 points)</td>
<td></td>
</tr>
<tr>
<td>Final draft (30 points)</td>
<td></td>
</tr>
<tr>
<td>Quizzes (4 x 10 points each)</td>
<td>40</td>
</tr>
<tr>
<td>Exams (4 x 50 points each)</td>
<td>200</td>
</tr>
<tr>
<td>Final exam</td>
<td>75</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>500</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% of Total Points</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 – 100</td>
<td>A</td>
</tr>
<tr>
<td>80 – 89.9</td>
<td>B</td>
</tr>
<tr>
<td>70 – 79.9</td>
<td>C</td>
</tr>
<tr>
<td>60 – 69.9</td>
<td>D</td>
</tr>
<tr>
<td>&lt; 60</td>
<td>Failing</td>
</tr>
</tbody>
</table>

Note: Individual exams may be curved if the average score is below 60%. Overall course grades will not be curved.

Extra Credit: Based on appropriate lab conduct and preparation, up to 15 points of extra credit may be added to the final point total (see below).

Exams:
Exams will be given during lecture periods. You will have an hour and twenty minutes to complete the exam. Questions will be a mix of multiple choice, fill in the blank, short answer, and essay.

If there is a reason you can’t take a quiz or exam **you must contact me before the test**. I will only consider giving a make-up exam if a student has documentation of an illness or emergency.

Lab Conduct:
During our Week 1 laboratory period, we will review the NEIU laboratory safety rules, and you will be required to sign the laboratory safety contract. Upon proper completion of the contract, each student will be granted 15 extra credit points.

Any time you commit a violation of the lab safety contract, I will subtract five points from this extra credit. You will also lose five points if you have an unexcused absence from lab. Five points will also be deducted if you are unprepared for lab (missing handout, lab notebook, dissection kit, or latex gloves) or have excessive tardiness.
# General Biology II
## Bio 202 – Spring 2010

### Tentative course schedule
Readings (given in parentheses) refer to chapters in Campbell and Reece 8th Edition

<table>
<thead>
<tr>
<th>Tue</th>
<th>Tuesday Lecture</th>
<th>Thu</th>
<th>Thursday Lecture</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/12 Introduction (Ch 1)</td>
<td>1/14</td>
<td>Evolution (Ch 22)</td>
<td>Lab safety Experimental design</td>
</tr>
<tr>
<td>2</td>
<td>1/19 Evolution of populations (Ch 23)</td>
<td>1/21</td>
<td>Speciation – <em>quiz 1</em> (Ch 24)</td>
<td>Natural selection simulation</td>
</tr>
<tr>
<td>3</td>
<td>1/26 Phylogenies (Ch 26)</td>
<td>1/28</td>
<td>Phylogenies cont. (Ch. 26)</td>
<td>History of Earth (Ch 25)</td>
</tr>
<tr>
<td>4</td>
<td>2/2 <strong>Exam 1 Ch 1, 22-26</strong></td>
<td>2/4</td>
<td>Ecology (Ch 52)</td>
<td>Aquatic plant ecology Experimental design</td>
</tr>
<tr>
<td>5</td>
<td>2/9 Ecosystems (Ch 55)</td>
<td>2/11</td>
<td>Community ecology (Ch 54)</td>
<td>Aquatic plant ecology Data collection/posters</td>
</tr>
<tr>
<td>6</td>
<td>2/16 Population ecology (Ch 53) – <em>quiz 2</em></td>
<td>2/18</td>
<td>Conservation ecology (Ch 56)</td>
<td>Poster presentations Climate change video Exam review</td>
</tr>
<tr>
<td>7</td>
<td>2/23 <strong>Exam 2 Ch 52 - 56</strong></td>
<td>2/25</td>
<td>Prokaryotic diversity (Ch 27)</td>
<td>Week 1 Bacteria</td>
</tr>
<tr>
<td>8</td>
<td>3/2 Eukaryotic diversity (Ch 28)</td>
<td>3/4</td>
<td>Plant diversity I (Ch 29)</td>
<td>Week 2 Bacteria Protists</td>
</tr>
<tr>
<td>9</td>
<td>3/9 Plant diversity I - cont. (Ch 29)</td>
<td>3/11</td>
<td>Plant diversity II (Ch 30)</td>
<td>Seedless plants</td>
</tr>
<tr>
<td>10</td>
<td>3/16 Plant diversity II – cont. (Ch 30) - <em>quiz 3</em></td>
<td>3/18</td>
<td>Fungal diversity (Ch 31)</td>
<td>Seed plants</td>
</tr>
<tr>
<td></td>
<td><strong>SPRING BREAK March 22 - 26</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>3/30 <strong>Exam 3 Ch 27 - 31</strong></td>
<td>4/1</td>
<td>Animal diversity (Ch 32)</td>
<td>Worm dissection</td>
</tr>
<tr>
<td>12</td>
<td>4/6 Invertebrates (Ch 33)</td>
<td>4/8</td>
<td>Vertebrates (Ch 34)</td>
<td>Crayfish dissection</td>
</tr>
<tr>
<td>13</td>
<td>4/13 Vertebrates (Ch 34)</td>
<td>4/15</td>
<td>Animal form/function (Ch 40) – <em>quiz 4</em></td>
<td>Frog dissection</td>
</tr>
<tr>
<td>14</td>
<td>4/20 Animal nutrition (Ch 41)</td>
<td>4/22</td>
<td>Circulation/gas exchange (Ch 42)</td>
<td>Writing lab</td>
</tr>
<tr>
<td>15</td>
<td>4/27 <strong>Exam 4 Ch 32 – 34, 40 - 42</strong></td>
<td>4/29</td>
<td>Animal anatomy paper review</td>
<td>Review for final</td>
</tr>
</tbody>
</table>

**Final Exam:** Tuesday May 4th – 8:00am – 9:50am

**Final Paper Due:** Wednesday May 5th – 5:00pm (submit by e-mail)

**Note that Friday April 2nd is the last day to withdraw from this class.**
Class conduct:
I expect each member of the class to conduct himself or herself honorably. Our classroom will function best in an atmosphere of mutual trust and respect. You can do your part in establishing such an atmosphere by treating others with the dignity and respect you would like for yourself.

I believe that all of us know how to conduct ourselves with honesty and integrity, and that we will do so to the best of our ability. If you have questions about the expectations of conduct at NEIU, please see the University Student Conduct Code at http://www.neiu.edu/Survival_Kit/policy_2.htm. Below are notable portions of the code:

Academic misconduct is an offense against the University. Acts of academic misconduct include but are not limited to:

1. Cheating. Use or attempted use of any unauthorized assistance in taking an exam, test, quiz, or other assignment. (Please note, cheating on exams includes all required University, state, and/or national assessment exams.)

2. Plagiarism. Appropriation or imitation of the language, ideas, and thoughts of another author and representation of them as one’s original work. This includes (1) paraphrasing another’s ideas or conclusions without acknowledgement; (2) lifting of entire paragraphs, chapters, etc. from another’s work; and (3) submission as one’s own work, any work prepared by another person or agency.

Please note that academic misconduct will not be tolerated in this class, and that such misconduct can result in failure of the course.
Lab 1 Biology 202: Design and Conduct Experiment with Aquatic Plants

At the end of this lab exercise students should be able to:
1) Keep a lab notebook that includes
   - name, partner name(s) and date
   - table of contents
   - question being asked
   - methods used to answer question
   - preliminary conclusions
2) Describe the growth of a population of aquatic plants
   - In distilled water
   - In water with nutrients added
   - In water with nutrients and NaCl added
   - In distilled water with a competitor
   These growth patterns will be described in mathematical terms using the language of Campbell chapter 52:
     - Density and dispersion (pp1136 -1137 Campbell)
     - Number alive at each observation
     - Number dead between observations
3) Present results of the work graphically using Microsoft Excel
4) Present results and logical interpretation of the work in poster format.

<table>
<thead>
<tr>
<th>Treatment (Use 200 mL per culture)</th>
<th>5 fronds <em>Lemna</em> (Groups 1 and 2)</th>
<th>5 fronds <em>Azolla</em> (Groups 3 and 4)</th>
<th>5 leaf pairs <em>Salvinia</em> (Groups 5 and 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass distilled water</td>
<td>Glass distilled water</td>
<td>Glass distilled water</td>
<td></td>
</tr>
<tr>
<td>0.5 X Hoaglands</td>
<td>0.5 X Hoaglands</td>
<td>0.5 X Hoaglands</td>
<td></td>
</tr>
<tr>
<td>1 X Hoaglands</td>
<td>1 X Hoaglands</td>
<td>1 X Hoaglands</td>
<td></td>
</tr>
<tr>
<td>2 X Hoaglands</td>
<td>2 X Hoaglands</td>
<td>2 X Hoaglands</td>
<td></td>
</tr>
<tr>
<td>1X Hoaglands made to 2.5% (w/v)NaCl</td>
<td>1X Hoaglands made to 2.5% NaCl</td>
<td>1X Hoaglands made to 2.5% (w/v)NaCl</td>
<td></td>
</tr>
<tr>
<td>1X Hoaglands made to 5% (w/v)NaCl</td>
<td>1X Hoaglands made to 5% (w/v) NaCl</td>
<td>1X Hoaglands made to 5% (w/v)NaCl</td>
<td></td>
</tr>
<tr>
<td>1X Hoaglands made to 10% (w/v)NaCl</td>
<td>1X Hoaglands made to 10% (w/v)NaCl</td>
<td>1X Hoaglands made to 10% (w/v)NaCl</td>
<td></td>
</tr>
<tr>
<td>Compete with 5 fronds <em>Azolla</em></td>
<td>Compete with 5 fronds <em>Lemna</em></td>
<td>Compete with 5 fronds <em>Lemna</em></td>
<td></td>
</tr>
<tr>
<td>Compete with 5 leaf pairs <em>Salvinia</em></td>
<td>Compete with 5 leaf pairs <em>Salvinia</em></td>
<td>Compete with 5 leaf pairs <em>Salvinia</em></td>
<td></td>
</tr>
</tbody>
</table>

Procedure:
1) Work in groups of 3-4. Each person will be held responsible for understanding, recording and interpreting ALL of the work and data of the group.
2) You will be assigned an aquatic plant either in the genus *Lemna, Azolla, or Salvinia*
3) Develop the plan that you and your lab mates will follow to accomplish your work. Check with your instructor as you develop your plan. Write your plan into your notebook so that you, or someone with a level of education similar to your own could replicate your work. Elements that your plan must include:
   a) Use labware provided. Be sure to label your cultures with your names, the date, and the organisms in your culture. Each culture of aquatic plants should be in its own beaker. Beakers must be covered with plastic wrap once the cultures are set up.
   b) Calculate the volume or mass of each culture component needed to make 200 mL of culture medium. Enter the complete counts into your lab notebook. **Note that the Hoagland's solution provided is 10X**
   c) Count the required number of fronds or leaf pairs into each culture. Record initial frond or leaf pair counts. **Be sure that fronds or leaf pairs are of similar sizes (ie don't fill one beaker with tiny fronds or leaf pairs, and a second beaker with large fronds or leaf pairs)**
   d) Place your labeled cultures on a plastic tray on the assigned shelves in the greenhouse.
Poster assignment (due week of Sept 24)

Purpose & goals
The purpose of this assignment is for you to communicate what you have learned about nutrients, NaCl, competition, and the aquatic plants that you have studied. Your audience will be your classmates and any faculty or staff who come to see your work. Your goal should be to accurately summarize your data and the literature (sources given below) that you have used to set your work into a larger context.

Instructions
Work in the groups in which you have done your experiment. You must divide work up into fair portions. Suggested portions are: 1) Introduction 2) Materials and Methods and image acquisition. 3) Results and graphing 4) Discussion. You should elect one person to be your "editor". The editor's job will be to coordinate the contributions of each member so that your finished product is cohesive. Job # 2 might well be combined with the job of editor. You must turn in a statement of how you divided up your work when you turn in your poster. Grading will generally be by group, but exceptions may be made if an individual has clearly performed differently from the group.

You must include a TITLE, YOUR NAMES, An INTRODUCTION, sections summarizing your MATERIALS/METHODS RESULTS, AND DISCUSSION. These sections should have the same sorts of information as the example posters on display in your lab. You should also have REFERENCES to your information sources. The sections should be titled. You should choose the main ideas that you want to communicate in each section and present your material so that your main message is evident.

Illustrations, digital images, text, etc. can all be used effectively to present your message. Most posters presented at professional meetings are prepared electronically in a program such as Power Point.

Your poster must include at least 3 citations in the literature cited section. Use the name and year system for your citations. Your citations should be from the following sources:

1) One of the Issues in Ecology publications
(Available at http://esa.org/science_resources/issues.php)
3) Your text.

If you wish you can search for other sources, but most students should simply use the three listed above.
Making a poster in Microsoft Power Point.

Make your poster on a single slide.
Open a new power point presentation
Text can be entered by clicking on the text box at the bottom of the screen.
For your electronic poster you will need to choose font type and size. Font size 4 will give a finished type size of about 5mm. Font size 22 will give a finished size of about 23mm. You can check your finished size by scaling the image on your screen up to a three foot by four foot size. You can visually estimate the effect by changing the screen size to about 400% size using the box at the top of your screen.

Lettering in your poster should be large so that it is easily readable from several feet away. You can vary font size to highlight important aspects of your poster (for example a large title). When you use photographs, drawings, or other illustrative material, be sure you refer to it clearly in the text (Figure 1, etc.) or place the text with the illustration. There are examples of posters in lab that you can use for ideas. Look for presentation methods that seem effective & use them. Avoid ways of presenting that seem ineffective to you.

Citing Literature ***Name and Year System***
When you use ideas or information that are not your own, especially if the information is not common knowledge, you need to cite the source. Use the name-and-year system to make your citations in this course. In this system one cites the last name(s) of the author(s) and the year of publication in the text, then give the full reference in your Literature cited section. Do not give page numbers in your in-text citation. Here are some examples:

Administrative and legal structures, such as the Endangered Species Act in the USA, regulate the sets of organisms that may be protected using limited public monies, and in general, more distinct groups of organisms are thought to warrant higher levels of effort than those which are less distinct (Holsinger and Gottlieb 1991).

When there are several authors don’t list them all, write “et al.” (which means “and others”)

Conservation biologists use information about the distribution of genetic variation within and among populations to set conservation priorities and plan management strategies (Hamrick et al. 1991).

Sometimes you will want to name the person who had the idea before you describe their idea as below:

Harrison et al. (1997) described five distinct groups of wild North American strawberries.

In general, direct quotes are not used in scientific writing. Use them only to make an extraordinary point. You should format your citations as in American Jornal of Botany. (find a copy of American Jornal of Botany in the library for examples of this method of citation). The CBE Style Manual (available in the reference section of the library) also has help with citations and good writing. References in the Literature cited section should be in alphabetical order by first author and in the style of references in American Jornal of Botany papers. The Literature cited section should contain all of the sources cited in your paper, and contain no sources not cited. You must use peer reviewed literature sources.
### Example Evaluation sheet for Posters (Bio 202)

#### Mechanics: (7pt)
- Poster includes all information required to identify the author(s) ................................................................. _____
- Title lettering is large enough to read from a distance of 2-3 meters ..................................................................... _____
- Font, font size and line spacing make the poster easy to read from a distance of 1 meter ........................................ _____
- The text and images (graphs, drawings and photos) chosen to include in the poster tells a complete story ............ _____
- The amount of text in each section is sufficient to convey the required information, and is not excessive. Images are well chosen, making the poster attractive and informative .................................................. _____
- The flow of information on the poster is easy to follow .......................................................................................... _____
- The poster has been proofread, and is free of typographical and grammatical errors ......................................... _____

#### Content: (8pt)
- The Introduction states the specific issue that was addressed, and places it in context ............................................. _____
- The Methods are presented in the form of a flow chart, schematic illustration, or as a simple list, but not in a “recipe” style ......................................................................................................................... _____
- The Methods section includes a description of the experimental design, equipment and basic techniques used, what data were collected, and how data were analyzed .................................................................................. _____
- The Results are presented concisely as appropriate and self-sufficient tables and figures or simple blocks of text ........................................................................................................................................ _____

#### Context: (10 pt)
- The significance of each result is stated explicitly, as a take-home message that relates to the specific research question or hypothesis being addressed ........................................................................................................... _____
- The Discussion section actually discusses the results as they relate both to the specific question or hypothesis addressed and the general context provided in the Introduction .................................................................................. _____
- Literature is cited appropriately in the text, and complete references (at least 3) for cited literature are included in the Literature Cited section .................................................................................................................. _____

#### Oral Presentation (5pt)
- Voice is audible ......................................................................................................................................................... _____
- Presenter is well organized ......................................................................................................................................... _____
- Presenter demonstrates thorough knowledge of the topic s/he is presenting .......................................................... _____
MATH DIAGNOSTIC, BIO 150

Part 1 (15 points): Answer the questions on the next page on a separate sheet of paper. Each of these questions comes directly from your textbook Math and Statistics for the Life Sciences. Once you have tried your best to answer each question, look at each question in the book and check your answer. Use a different colored pen to make any corrections or to note if you got the answer correct originally.

Grading: You will receive credit for each correct answer, whether you answered it correctly on your own or if you corrected it after looking at the explanation in the textbook. TRY TO ANSWER QUESTIONS ON YOUR OWN FIRST--there is no penalty for getting them wrong, as you get credit for correcting them.

Part 2 (10 points): Look over your corrected answers to the problems and reflect on how you did. Which questions were easy for you? Which did you struggle with? Are there still questions that you don’t understand how to answer correctly? How might you be able to improve in the areas that you struggled? Type your responses to these questions and include any other observations about your performance on this diagnostic. (I expect approximately half a page here.)

Grading:
9-10 points: Reflective statement about your performance is thoughtful. Based upon what you’ve learned, you’ve explained areas that might be problematic for you and how you can improve in those areas.

7-8 points: Reflective statements about your performance is thoughtful, but you haven’t gone the extra step to think of specific ways to improve your math abilities.

6 points or less: Reflective statement or suggestions for improving study habits are vague.

Due Date: For full credit, you must turn in both part 1 and part 2 at the beginning of class next week.
1. Calculate $7(4+3)(5-2)$ (Question 2.2, p. 5)

2. Calculate $5/6$ of 72 (Question 3.1, p.8)

3. What is the decimal equivalent of 1 and $5/8$ (Question 3.8, p.8)

4. A stalk of common wheat, *Triticum aestivum*, measures 625 mm in height. In 1 week it grows by 12%. How tall is the stalk after 1 week of growth? (Ex. 4.3, p.9)

5. An onion leaf epidermal cell, *Allium cepa*, is 0.000045 m long. Give this value in standard form (scientific notation). (Question 5.1, p.15)

6. Human genomic DNA is made up of approximately $3 \times 10^9$ base pairs. Give this number in ordinary form (not scientific notation). (Question 5.2, p.15)

7. A sample of water has $2.2 \times 10^3$ bacteria per liter. How many bacteria would there be in 36,000 liters of water? (Ex. 5.4, p.14)

8. How many significant figures are there in each of the following? (Example 6.2, p.16) (Question worth 4 points total)
   a. 10.54
   b. 6,754,000
   c. 0.0004832
   d. 0.8760

9. Simplify $\frac{a^2b}{a^3} \times \frac{a^4b^2}{b^3}$. (Question 9.2, p.32)

10. Multiply out $5a(2a-b^2)$. Question 9.5, p.32)

11. Solve for $x$: $3x^2 = 12$ (Question 11.1, p.38)

12. Make $y$ the subject of the equation (that is, isolate $y$ on one side of the =). $x = 4y^3 + 1$ (Question 11.2, p.38)
Guidelines for Field & Laboratory Notebook

Goals:

>> To help you establish effective field and lab research habits.

>> To provide a way for me to evaluate your understanding of the material presented in lab and how well you were able to accomplish the goals of the lab exercises.

>> To preserve a contemporaneous record (i) of the methodologies and techniques used in experiments that you conduct, and (ii) of the data that you (or others) collected - in its original form.

>> To provide a place where you can analyze data and present the results of experiments in summarized forms (summary statistics, figures, tables), and where you can make sense of data in the context of the goals of each experiment. In other words, to tell the complete story of an experiment, from beginning to end.

Specific Guidelines:

>> Use a bound notebook that does not allow for the (undetectable) removal or insertion of pages.

>> Use a pencil or permanent pen that writes well on damp paper and vertical surfaces. Always cross out mistakes with a single line - never erase or use white-out to correct mistakes.

>> Set aside the first 3-4 pages where you can maintain a table of contents: this is a useful way to find entries on a specific project, and allows you to keep track of entries scattered throughout a notebook that are related to a single project that spans a long period of time.

>> Write data and notes clearly and legibly enough so that anyone can easily read your notes.

>> If a section of your entry is out of order (e.g., your introduction follows your results, rather than coming first), indicate, at the point where it is expected to be, exactly where it can be found.

>> Do not skip pages or leave large spaces on pages blank. If you do not use part of a page, draw a diagonal line through the unused portion. Do not tear pages out of your notebook.

>> Record all relevant information for each entry. In addition to your data, write down the date (on each page) time, location, prevailing weather or lab conditions (but only if relevant) and any other potentially relevant conditions, events or observations.

>> Notes and data are uninterpretable without context: indicate the purpose or general goals of each lab at the beginning of any entry. Also provide a brief but complete description of the methods you used to collect data, lists of any abbreviations you use, and any modifications of protocols. Providing methods in the form of a flowchart is a good way to make your methods clear and understandable.

>> Prepare data-collection tables in your notebook before coming to lab, if possible. If you do this, you can record data more quickly while still keeping your notes clear and eligible. (Because you will often be deciding on experimental protocols as part of the labs, this will not always be possible.)

>> Record data directly into the lab notebook, and indicate what the data represent and the units of measurement. Do not record data on separate scraps or sheets of paper, with the intention of copying it into the notebook later - these can be too easily lost, and you may make errors while transcribing them into the notebook.
If you are working in a group, only one person needs to record the data while you are conducting an experiment - the other members of the group can copy the data from the one original, preferably before leaving the lab. However, if the data in your notebook are copied from the originals, you must indicate who has the original copy of the data.

Use a ruler or straight-edge when you prepare tables or graphs, choose appropriate scales for the axes of graphs (so that you can accurately plot points on the graph), and label your axes clearly.

If you generate data sets or figures on a computer, or perform statistical analyses using a spreadsheet program or statistics package, and want to include them in the notebook, attach copies of them securely (e.g., with transparent tape along all sides) to both the original (white) and carbonless copy (yellow) sheet in your notebook. In addition, you should keep all of your data and analysis files on a single floppy disk (and a current backup), and should record in your notebook the name(s) of the relevant file(s), and notes as to what the data included in the files represent.

Finally - your notebook should be complete but succinct. Write only as much as is necessary to accomplish its purposes, but don’t omit relevant details, because:

"What is good is doubly so, if it be short / and in like manner, what is bad is less so if there be little of it."
- Baltasar Gracian (1601-1658)

General guidelines:
Each entry should begin with the date the entry was made. After this, each entry (or set of entries related to a given experiment or study) should be organized into a report with the following structure:

1. **Purpose/Introduction** - This is a short paragraph that describes briefly what you will be doing and why. It is not the introduction from the handout that I may provide, but should state **in your own words** the goals of the experiment, the technique or methods being used, and summarize briefly the theory or principles that underlies the technique or method. In other words, you provide the context for the experiment that is described in the following sections. It should state why the experiment is being done (i.e., **what you’re supposed to learn by doing it**), not merely what is being done.

2. **Materials/Methods** - There are several things that should be included in this section.

First, you should indicate the study organism(s) or the kind of system that is being studied.

Second, you should indicate the location that the experiment is being conducted (i.e., the study site if it is being done in the field, or a statement that it is being done in the lab), and the conditions under which the experiment is conducted (i.e., the current or recent temperature and weather conditions if it is in the field, or any conditions that exist in the lab). The key here is to record any conditions that could influence the outcome of the experiment, so that you can interpret your results meaningfully, after the fact.

Third, you should describe the methods used to conduct the experiment and to collect the data clearly, and in sufficient detail so that potential biases that the materials or methods might introduce can be identified, and so that anyone reading your lab notebook could faithfully repeat your experiment. You may want to list the materials used in a separate table, but it is also appropriate to write the materials and methods as a narrative, indicating the materials used as they come up. In the methods section, you should indicate the data that are collected, exactly how the data were collected, and both the units of measurement and the precision of the measurements (e.g., “we measured leaf width at the widest point of the leaf blade with a 15-cm plastic rule to the nearest mm.”). You may find it easier to construct a flow chart of the experimental procedure along the left side of the page, and provide details or indicate modifications of the procedure along the right side of the page.
3. **Results** - In the first part of this section, you should record the data that you collect during an experiment. The data must be recorded directly into the notebook, as noted in the general guidelines above. The raw data should be neat, well-organized in simple columns or tables, and should be well-documented as to what the numbers represent (leaf width in mm, dry weight of caterpillars in grams, concentration of dissolved oxygen in parts per million, etc.). The second part of this section should include the calculations, analyses and graphical representations that turn your raw data into interpretable experimental results. In some cases, the analysis will be the calculation of summary statistics (mean, standard deviation, standard error of the mean) or the calculation of an inferential statistic (e.g., performing a t-test, which lets you objectively assess whether or not the means of two groups are statistically significantly different). Likewise, the kinds of graphs you produce will vary depending on the experiment - you may need to produce histograms (that show frequency distributions), scatterplots (that show the relationship between two variables) or bar-charts (that compare the means of two or more groups) to present the results in easily digestible forms.

4. **Discussion** - In this section, you interpret the results of the experiment, and discuss the final results. Summarize the results in words, discuss whether the lab worked as expected, how well the method accomplished its goals, whether the method appears to produce reliable results, what could account for discrepancies between what you observed and what you expected, what could account for the amount of variation associated with a particular estimate (e.g., of population size estimated by a mark-recapture study), whether the experimental design seemed to be adequate or insufficient, etc. In addition, you should address in this section specific questions that I provide for any given lab. However, it is not sufficient to merely address all of these kinds of questions in a haphazard way - the discussion should be organized logically and be readable, and broken into paragraphs that treat separate ideas and topics coherently.

**Grading criteria**: Each section of your lab notebook entries will be graded with respect to how well they fulfill the criteria described above, on a scale of 0 (not at all) to 10 (fulfills all criteria). I will be looking for the following in each section:

**Introduction/Purposes**: Provides meaningful context and background information for the exercise, and identifies the ultimate goals of doing the exercise (rather than merely states what was done).

**Materials/Methods**: Describes the species or system being studied, the conditions under which the experiment was conducted, and provides sufficient details of the methods used in an accessible format so that someone else (who is not in the class) could faithfully repeat the experiment and get comparable results.

**Results**: Presents raw data neatly, presents data in appropriate and clearly labeled summary graphs and tables, and analyzes the data in appropriate ways, such that someone else (not taking the class) could understand what the data/figures/tables represent and how the data were analyzed.

**Discussion**: Effectively presents and interprets the results of the experiment in the context of the goals stated in the introduction, discusses sources of error, assesses the quality and limitations of the experimental design used, and answers any assigned questions, all in a well-organized presentation.

In addition, I will evaluate the Overall Quality of your notebook, which should be neat and legible, be written in clearly understandable and grammatically correct English, have good overall organization, and should otherwise adhere to the requirements laid out in the “General Guidelines” above.
Writing a Primary Research Paper

**TASK:** Using data collected during your group research project, write a primary research paper, with abstract, introduction, methods, results, discussion, acknowledgements, and literature cited sections.

**AUDIENCE:** The “audience” for your paper is a beginning biology student who has taken General Biology I & II but has not yet taken General Ecology (you, before you began this class). Any information that you wouldn’t expect a typical beginning biology student to know must be supported by a citation- it *cannot* be assumed to be “general knowledge.” (If in doubt, it is probably best to provide a citation.)

**PURPOSE:** There are several purposes for this assignment.
1. Interpret the data you collected, based upon your knowledge of ecology.
2. Conduct a search of the primary literature to find research articles related to your research.
3. Compare your data to that published in the primary literature.
4. Write a primary research paper for *your* data, with abstract, introduction, methods, results, discussion, acknowledgements, and literature cited sections.

**FORMAT:** A primary research paper explains *why* you did the investigation, *how* you did it, *what you found*, and whether your findings were significant and useful. This information is explained in the following sections: 1) abstract, 2) introduction, 3) methods, 4) results, 5) discussion, 6) acknowledgements, and 7) literature cited. Write in an *active voice*. **Total length: 7-9 pages.**

1. **The abstract**, a summary of the paper, is written last. It summarizes important information from the introduction, methods, results, and discussion sections.
2. The **introduction** contains a) justification of the importance of the research (why did you address this question?), b) background information to enable the reader to understand the question being investigated, and ends with c) a statement of research objectives.
3. **Methods:** This is a “cookbook” section detailing how you did your investigation. In an ecological paper, it includes a) study site description, b) field methods, and c) lab methods. You must write in *past tense*, in *paragraphs* (unlike your lab or field notebook).
4. **Results:** This section presents the empirical results of your investigation. Graphs and tables must contain sufficient information to stand alone, including units, labels for each axis, and a table heading or figure caption. The most significant data in the graphs and tables is summarized in text. (Imagine that the figures are displayed on a screen and that you are explaining them orally, using a pointer. Your written text should transcribe what you would say orally.) Because you have already obtained your results, write in *past tense*.
5. **Discussion:** This is the main part of the paper, the part that will be read with the most care by other professionals. Here you a) provide a scientific explanation for your data, b) compare your data to the broader scientific literature (to data found by other researchers), and c) make recommendations for future research. Some questions to ask yourself:
   - Did your investigation accomplish the purpose that you explained in your introduction? Did it answer your questions? **The key to success in the discussion section is to link your findings to the questions and problems raised in the introduction.**
   - Are your results useful? Why or why not?
   - Did you discover information that you hadn’t anticipated?
   - Was your research design appropriate? Did your investigation raise new questions? Are there implications from your results that need to be further explored?
6. **Acknowledgements:** A brief section in which you thank those who helped or provided equipment, supplies, access to field site, etc.
7. **Literature Cited:** Full citations are given for all sources cited within the text of the paper.

EXAMPLE: For an example of a primary research article that you can use as a model for your paper, refer to the article you analyzed during class (Panzer & Schwartz 2006).

RESOURCES:
1. Biological Abstracts database: [http://library.neiu.edu/doityourself/databases.html#B](http://library.neiu.edu/doityourself/databases.html#B)
2. Writing Papers in the Biological Sciences textbook, by McMillan, particularly chapters 3 (using tables and figures), 4 (writing lab reports and research papers), 6 (documenting the paper), and 7 (drafting and revising).
3. The online grammar diagnostic at [http://bcs.bedfordstmartins.com/rewriting/](http://bcs.bedfordstmartins.com/rewriting/) will help you recognize your grammar mistakes. Click on Exercise Central: Diagnostics, which is in the list of items below the “Grammar + Style” heading. Then click on Kathleen McWhorter’s Successful College Writing, then visit the Web site for the Second Edition at the top of the page. Finally, click on Grammar Diagnostic.
4. You can receive one-on-one help during any stage of the writing process from the Writing Lab ([http://www.neiu.edu/~ewlab/](http://www.neiu.edu/~ewlab/)) or the Center for Academic Writing ([http://www.neiu.edu/~wip/](http://www.neiu.edu/~wip/)). Take advantage of this opportunity! Some students find single appointments to be helpful, while others make a standing appointment to meet with a writing tutor each week. To ensure that you get the help you need, make your appointment early. Bring a copy of this assignment sheet and the McMillan textbook to your appointment.

DUE DATES:
1. Draft (25 pts.) Complete and turn in the “checklist” along with your draft. **DUE Mon. Nov. 30**
2. Rewrite (50 pts.) Make improvements based on comments received. **DUE Wed. Dec. 9**
3. Second rewrite (optional) After meeting with your instructor to discuss how to further improve your writing, you can submit another rewrite. The grade for the second rewrite will replace the grade for the first rewrite. This option requires that you make an appointment with the instructor to individually discuss your paper at least one week before the due date. **DUE Fri. Dec. 18**

EVALUATION CRITERIA:
1. Draft: If each element on the “evaluation criteria for draft” checklist (p. 3-4 of this handout) is included in your draft, you will receive 25 pts. One pt. will be deducted for each missing element.
2. Rewrite: For the rewrite, you will be evaluated on how well you write the content of each element. In addition, grammar, structure, and style will account for 20% of the grade. Please see the “evaluation criteria for rewrite” on p. 5-7 of this handout.

ADDITIONAL INFORMATION:
1. Feel free to discuss your data with your labmates or with anyone in the class. However, when it comes time to write, you must do the writing on your own. Plagiarism is a very serious offense. If even one sentence or long phrase is copied, whether the source is your textbook, the internet, another student, or any other source, you are committing plagiarism. (If a copied sentence or phrase is in quotes, then it’s not plagiarism. However, quotations are rarely used in scientific papers and are not to be used in your paper.) If you have questions about what constitutes plagiarism- ask!
2. A certain way to avoid plagiarism is to always write in your own words (paraphrase). However, if you follow the original phrasing too closely, you won’t be paraphrasing, but plagiarizing. To review how to paraphrase appropriately, please go to [http://bcs.bedfordstmartins.com/rewriting/](http://bcs.bedfordstmartins.com/rewriting/) Click on “Avoiding Plagiarism Tutorial” and then “Taking Notes.” Complete the “Recognizing paraphrases” and “Writing Paraphrases” activities.
3. Grades for a late submission will be penalized 10% for each calendar day it is late.
4. Please don’t hesitate to visit my office hours or to make an appointment outside office hours, to discuss your paper during any stage of the writing process. Students who seek feedback find the writing process to be easier and produce a much better paper.
EVALUATION CRITERIA FOR DRAFT

Check that your draft has each of the following elements. Complete this checklist and turn in with your draft. Drafts are worth 25 points. Drafts that include each of the required elements below will receive full credit, with one point deducted for each missing element.

Plagiarism: I certify that all words in this paper are my own, and understand that conducting plagiarism is a very serious offense. (In other words, appropriately summarize information from other sources in your own words and provide citations.) Sign here: _____________________________

Title
______ Is title complete? (Name each variable studied and the study site. Example: “Relationship between nutrient concentrations, conductivity, and benthic macroinvertebrates in the Chicago River.”)

Abstract
_____ Contains 1-3 sentences summarizing introduction.
_____ Contains 1-3 sentences summarizing methods.
_____ Contains 1-3 sentences summarizing results.
_____ Contains 1-3 sentences summarizing discussion.

Introduction
_____ Is sufficient background information included?
_____ Is there no extraneous information that doesn’t add to understanding of research objective?
_____ Is importance of research explained (why this research is necessary)?
_____ Is all information that a typical beginning biology student would not be expected to know appropriately cited?
_____ Does introduction end with clear, concise, and thorough statement of the research objective(s)?

Methods (Write in paragraphs, just as in the rest of the paper. Write in past tense).
_____ Description of study site: Have you described aspects of study site that could potentially affect results (e.g. habitats in which samples were collected)?
_____ Field work: Have you included all necessary information (sampling methods, equipment used, etc.) for someone to repeat experiment?
_____ Lab work: Have you included all necessary information (sampling methods, equipment used, etc.) for someone to repeat experiment? (If you identified organisms, cite taxonomic keys used.)
_____ Have you not included unnecessary information (info that wouldn’t be necessary to know if experiment were repeated)?

Results
Text in results section (write in past tense):
_____ Does text summarize the “main gist” of the data rather than simply repeat the data?
_____ Does text summarize only the results, without discussing the meaning of the results and without repeating the methods?
_____ Are figures and/or tables appropriately numbered and referred to in parentheses (Figure 1)?

Figures and Tables:
_____ Do figures (graphs, pictures, or drawings) not have a title but have a figure number and caption below the figure? Do tables have a table number and table heading at the top of the table?
_____ Can figures and tables stand alone- units given, axes labeled, etc? (The reader should be able to understand the figure or table without referring back to the text.) Note: Writing Papers in the Biological Sciences, by McMillan, gives clear guidelines for figures and tables.
Discussion

Is the scientific meaning of the data explained? (Why do you believe that you obtained the results you obtained? Based on your scientific knowledge, were the results as you expected?)

- Note: I’ll be looking for depth of thought here. If you’re not sure how you might interpret your data, look up appropriate terms in the glossary of your textbook and read about those factors. Do a literature search to find similar research that others have done, and read about how they interpreted their data.

- The key to success in the discussion section is to link your findings to the questions and problems raised in the introduction.

If any potential problems or errors occurred that may have affected results, have you discussed them?

How does your data compare to published research? Compare your data to at least 3 primary research papers. Vague statements about data in those papers will receive little to no points, while thoughtful, detailed comparisons that refer to specific data in those papers will receive more credit.

What should be studied next? Were there limitations or errors in your methodology that could be addressed by future research? Or, does your data suggest a new research objective to test?

Acknowledgements:

Have you thanked those who provided equipment, facilities, or access to field sites? Did you thank your labmates for helping to plan the research and collecting data? Was anyone else particularly helpful?

Literature Cited section

Does this section include a complete citation for each source cited in the text of the paper?
EVALUATION CRITERIA FOR REWRITE

Rewrites are worth up to 50 points. Please note that grammar, structure, and style are worth 20% of the grade.

**TITLE**
- Thoroughly but concisely describes content. (3 pts.)
- Thoroughly describes content, but contains unnecessary words. (2 pts.)
- Missing a key feature (factor tested, study site location, etc.). (1 pt.)
- Title missing. (0 pts.)

**ABSTRACT**
- Summarizes most important aspects of introduction, methods, results, & discussion, with flow from one section to the next. (4 pts)
- Adequate information is given, but doesn’t flow well from one sentence to the next. (3 pt.)
- Summary is missing one important aspect. (2 pts.)
- Summary is missing more than one important aspect. (1 pt.)
- Abstract is missing. (0 pts.)

**INTRODUCTION**
- Background information necessary to understand research objective is thorough. (3 pts.)
- An important aspect is missing from the background information. (1-2 pts)
- Background information is insufficient (more than one important aspect is not included). (0 pts)

- Necessity/importance of research is thoroughly explained (2 pts.)
- An important aspect is missing from the explanation of necessity/importance of research. (1 pt.)
- Explanation is insufficient (more than one important aspect is not included). (0 pts.)

- Statement of research objective(s) complete, clearly stated, and concise. (2 pts)
- Information in statement of research objective(s) complete, but could be stated more clearly or in fewer words. (1 pt.)
- Statement of research objective(s) incomplete (missing a key aspect). (0 pts.)

**METHODS**
- Description of study site thorough- includes information about study site that may affect results and information that helps the reader understand habitats where samples were collected. (1 pt.)
- Field methods (how samples were collected, equipment used, etc.) described. (1 pt.)
- Lab methods (how samples were analyzed in lab, equipment used, etc.). (1 pt.)
- Enough information is included to allow someone to repeat the research objectives, but extraneous, unnecessary information is not included. (1 pt.)

**RESULTS**
- Tables headings/figure captions: (2 pts.)
  - Tables and/or figures appropriately numbered with figure captions or table headings that contain all the necessary information. (2 pts.)
  - Tables and/or figures inappropriately numbered or with necessary information missing from figure captions or table headings (1 pt.).
  - Table headings or figure captions absent (0 pts.)
Presentation of data in tables or figures:
- Data presented in organized, logical form, tables and/or figures can ‘stand alone’ (e.g. axes labeled, units given, symbols explained, etc. (2 pts.)
- Data presented in organized, logical form, but tables and/or figures cannot ‘stand alone.” (1 pt.)
- Data not presented in organized, logical form. (0 pts.)

Text in results section:
- Text in results section doesn't simply repeat data, but summarizes important aspects. (3 pts)
- Summary of data is complete but somewhat unclear. (2 pts)
- Important aspect missing from summary. Or, methods restated, or analysis included that belongs in discussion. (1 pt.)
- Text in results section is absent. (0 pts)

DISCUSSION

Scientific explanation of data:
- Thorough, thoughtful, and clear explanation of scientific factors that may have caused the patterns observed in your data. (4 pts.)
- Explanation of scientific factors should be more thorough (an important aspect is missing from explanation or a portion of explanation is unclear). (2-3 pts.)
- Explanation of scientific factors is insufficient (more than 1 important aspect is missing or unclear). (0-1 pts.)

Comparison of data to at least 3 primary research papers in published literature:
- Comparison is detailed, thoughtful, and thorough (5-6 pts.)
- Comparison is detailed, but could be more thoughtful. (3-4 pts.)
- Comparison is vague (your data is not specifically compared to their data.) (1-2 pts.)
- Comparison is insufficient (0 pts.)

Suggestions for future research:
- Suggestions given for future research are thoughtful and based upon your data and/or limitations of the current study. (2 pts.)
- Suggestions given for future research are vague or not based upon your data or limitations of the current study. (1 pt.)
- Suggestions are not given for future research. (0 pts.)

ACKNOWLEDGEMENTS

- Appropriate information included (labmates who helped, institutions or individuals providing access to field sites, facilities, equipment, etc.) (1 pt.)
- Information lacking or inappropriate. (0 pts.)

LITERATURE CITED

- Citations in literature cited section and in text of paper are in correct format. (2 pts.)
- Citations included in literature cited section and in text of paper, but format has incorrect aspects. (1 pt.)
- Some citations missing from text of paper or from literature cited section (1 pt.)
OVERALL GRAMMAR, STRUCTURE, & STYLE          Pts. possible: 10

Resources to help you improve grammar, structure and style:
- Complete the online grammar diagnostic at http://bcs.bedfordstmartins.com/rewriting/ to help you recognize common mistakes you make. Click on Exercise Central: Diagnostics, which is in the list of items below the “Grammar + Style” heading. Then click on Kathleen McWhorter’s Successful College Writing, then click on visit the Web site for the Second Edition at the top of the page. Finally, click on Grammar Diagnostic.
- Read chapter 7 of your McMillan textbook, which gives guidelines for revising your writing to be as clear and concise as possible.
- Take advantage of free, one-on-one instruction with grammar, structure, and style from the Writing Lab (http://www.neiu.edu/~ewlab/) or the Center for Academic Writing (http://www.neiu.edu/~wip/).

Structure:
- Each paragraph has a topic sentence, with every sentence in that paragraph related to the topic sentence. Each sentence in a paragraph flows from the previous sentence, with appropriate transitions from one paragraph to the next. (2 pts.)
- In some parts of paper, ideas jump around (aren't properly separated into paragraphs with topic sentences, or without transitions from one paragraph to the next). Or, there are jumps of logic within a paragraph (each sentence doesn’t flow from the last or there are sentences that don’t relate to the topic sentence). (1 pt.)
- Structural problems described above aren't rare but common (occurring in 3 or more places in paper). (0 pts.)

Grammar:
- Written primarily with an active voice. Grammar mistakes are rare (1-2 in entire paper). (2 pts.)
- Written primarily with a passive voice, or grammar mistakes are common (3-5 in paper). (1 pt.)
- Written primarily with a passive voice and grammar mistakes are frequent (>5 in paper). (0 pts.)

Overall conciseness:
- Language is concise throughout. (2 pts.)
- Language is overly wordy in some of paper. (1 pt.)
- Language is overly wordy in much of paper (in three or more places in paper). (0 pts.)

Overall clarity:
- Explanations are clear (no jumps in logic) throughout. (2 pts.)
- Explanations are unclear (jumps in logic) in some of paper. (1 pt.)
- Explanations are unclear (jumps in logic) in much of paper (in three or more places in paper). (0 pts.)

Audience:
- Explanations given without jargon so that a typical beginning biology student could understand. (2 pts.)
- Some of paper is not written in language that a typical beginning biology student could understand. (1 pt.)
- Much of paper is not written in language that a typical beginning biology student could understand (in three or more places in paper). (0 pts.)

TOTAL PTS. POSSIBLE: 50
Assignment to write a Persuasive Letter, Fall 2009

Your submission should be the equivalent of about 1 typed page (double-spaced, 12-pt. font, 1” margins).

You work for the U.S. Forest Service and you’ve been called to testify before Congress about the ability of forests to respond to increasing CO\textsubscript{2} concentrations. You are asked whether applying nitrogen fertilizer to forests will increase their ability to sequester CO\textsubscript{2} from the atmosphere. In your answer, be sure to thoroughly explain the following.

A) Explain why increasing in the amount of CO\textsubscript{2} in the atmosphere can lead to N limitation.
B) If plant growth becomes limited by N, could fertilizing with N theoretically increase a forest’s ability to sequester atmospheric CO\textsubscript{2}? Explain.
C) Why does N fertilization not increase CO\textsubscript{2} sequestration over the long term? (Don’t forget to explain how N affects ozone concentrations, and the effect of ozone on forest growth.)

Remember that you are writing for an audience of non-experts. Explain concepts step-by-step, so that members of Congress can understand your arguments.

I will be looking for
- Thorough, step-by-step explanations that a non-expert can understand.
- Organization- the reader can easily follow the “flow” of your “story,” or the argument you are presenting. In other words, each point builds upon the previous point.
- The statements you make are specific, not vague. Points are supported by data, such as results of research studies. Results of research studies are explained, not simply listed.
- Make each word count- write concisely.
- Correct grammar.

Note on plagiarism: Write in your own words. Paraphrase rather than directly quote text from the Beedlow et al. (2004) paper.

<table>
<thead>
<tr>
<th>GRADING:</th>
<th>3 pts.</th>
<th>2 pts.</th>
<th>1 pt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding of scientific concepts</td>
<td>Accurate and thorough (no crucial information left out).</td>
<td>Accurate, but some crucial information necessary for understanding concept is missing.</td>
<td>Much crucial information necessary for understanding concept is missing. Or, information provided is inaccurate.</td>
</tr>
<tr>
<td>Specificity</td>
<td>Specific information or data provided.</td>
<td>Some vague rather than specific phrases.</td>
<td>Many vague rather than specific phrases.</td>
</tr>
<tr>
<td>Clarity</td>
<td>Step-by-step explanation that a non-expert can understand (each sentence builds upon the previous sentence).</td>
<td>Each sentence does not build upon the previous sentence in some parts.</td>
<td>Each sentence does not build upon the previous sentence in many parts.</td>
</tr>
<tr>
<td>Conciseness</td>
<td>Explanations written in as few words as possible.</td>
<td>Explanation a little wordy, with unnecessary, “empty” phrases</td>
<td>Explanation very wordy, with entire ideas repeated.</td>
</tr>
<tr>
<td>Grammar</td>
<td>Little or no (0-2) grammar mistakes</td>
<td>Grammar mistakes common (3-5)</td>
<td>Grammar mistakes frequent (&gt;5)</td>
</tr>
</tbody>
</table>
M.S. in Biology at NEIU: Program Overview

The graduate program is designed to: serve students who intend to work in various capacities for which advanced biological training is necessary; serve secondary education teachers seeking advanced training for promotion and professional development; and provide a sound basis for further graduate or professional study. Laboratory work and introduction to research methodology are integral to the program. Faculty members who contribute to the Biology M.S. program have expertise in a broad range of subdisciplines including ecology, organismal biology, and cell and molecular biology.

Program Goals

Upon completion of the Biology M.S. program students will have:

1. A strong understanding of disciplines across the breadth of Biology and a deep understanding of select Biology sub-disciplines.
2. Developed the knowledge base necessary to critically evaluate research methods and results as published in the primary literature.
3. Developed the skills to evaluate and explain research data (either their data or data from the published literature).
4. Developed good written and oral presentation skills.
5. Developed strong research design and laboratory/field research skills.
6. Developed the analytical skills necessary to synthesize an explanation of an area of research based on existing and new data.

Graduates completing the Non-Thesis or Library Thesis options for the Biology M.S. will meet goals 1-4. Graduates completing the Research Thesis option will meet all of the goals:

Admission Requirements

Note: Applications for admission to the Biology M.S. program are accepted twice a year: April 1 and October 1 for Fall and Spring semester admission, respectively.

Application forms for admission to the program may be obtained from, and must be submitted to, the Graduate College. All students must fulfill the general requirements for admission to the Graduate College. In addition, all students must meet the following requirements for admission to the Biology M.S. program:

1. A Bachelors degree in Biology or the course equivalent. The undergraduate course work must include both the Biology and related science (Chemistry, Physics and Math) courses that are standard components of the Biology major. That is, two semesters each of General Biology, General Chemistry and Physics, one semester each of Cell Biology, Ecology, Genetics, Organic Chemistry and Precalculus Mathematics or Statistics. General Education courses cannot be used to satisfy the Biology or cognate area requirements. Note: Undergraduate students who have not yet completed the Bachelors degree are welcome to apply. Acceptance will be contingent on completion of the undergraduate degree and submission of official transcripts to the Graduate College indicating that the degree was conferred.
2. An undergraduate GPA of 2.75, with a GPA of 3.0 in the major/cognate area, is required for full admission to the program.

3. Applicants must provide a typed two-page statement of Goals and Objectives as part of their application. This statement should demonstrate the student’s writing skills and should specify as clearly as possible academic/professional goals and the reasons for selecting the Biology program of study.

4. Letters of recommendation (two required) should be from academic (former or current professors) or work-related supervisors who are able to assess the applicants’ potential for advanced study.

5. The Graduate Record Examination (GRE) is a nationally recognized indicator of the verbal and written skills necessary for success at the graduate level of study. GRE scores are not required for admission, but they may be submitted to supplement an application.

Provisional Admission may be granted in exceptional circumstances, as described below.

1. Applicants lacking 9 credit hours or less of required Biology or cognate area prerequisite course work (see above) may be eligible for provisional admission, but will be required to make up the deficiencies before candidacy will be granted.

2. Students with a major/cognate GPA of 2.50 - 2.99 may qualify for provisional admission.

Decisions regarding provisional admission are made on a case-by-case basis.

Degree Requirements

The Biology program allows students to tailor their program of study to meet their individual needs. Students may attend full-time or part-time and have up to 6 years to finish their Master’s Degree requirements. Graduate courses are offered during the late afternoon and evening hours. Courses that are lecture only, meet one evening per week (Fall & Spring semesters). Courses that include a laboratory/field component meet two evenings per week. All graduate students are required to take BIO 405 - Biological Literature.

The department offers three Graduate Options:

Research Thesis - this option is recommended for individuals who are interested in a career in biological research, are working in applied fields of Biology or are interested in further graduate/professional studies. Students interested in this option should arrange appointments with faculty in their area of interest and the graduate program advisor early in their program, to discuss potential thesis topics.

Students pursuing this option must complete a minimum of 33 credit hours of graduate course work, including BIO 405 - Biological Literature (3 cr) and BIO 499x - Research Thesis (6 cr. total). Students must have advanced to candidacy before they can submit the research proposal and the proposal must be approved by the Biology Department before the student can register for thesis research credits. A public, oral defense of the completed thesis is required.

Library Thesis - this option is recommended for students who are interested in exploring a particular topic through literature research. Following acceptance to candidacy the student will choose a library thesis advisor who will guide the student in identifying an appropriate question,
preparing a thesis proposal and writing the thesis. The goals of the library thesis are to explore a specific topic through the current literature with the aim of determining whether a specific question or questions can be answered through existing knowledge or whether additional experimentation/research are required to address the question.

Students pursuing this option must complete a minimum of 34 credit hours of graduate course work, including BIO 405- Biological Literature (3 cr.) and BIO 497x- Library Thesis (4 cr. total). The student must have advanced to candidacy and have obtained department approval of the thesis project before registering for BIO 497x credits. A public, oral defense of the completed thesis is required.

**Non-Thesis** - this option is recommended for students who desire a more flexible approach to graduate training in Biology, and who are not interested in a research career. It is a popular track for those in teaching or using the MS to become more competitive for admission to professional/health programs.

Students must complete a minimum of 36 credit hours of graduate course work, including BIO 405- Biological Literature (3 cr.), and BIO 491- Graduate Seminar (3 cr.).

**Candidacy**

Students need to apply for candidacy after they have completed 12 credit hours of course work, including BIO 405- Biological Literature, with a GPA of at least a B (3.0). Students admitted on a provisional basis must satisfy all prerequisite deficiencies before they can receive candidacy. Students need to satisfy their candidacy requirements and be declared candidates for the degree before they can register for either library or research thesis credits, or for the Graduate Seminar. Candidacy also is a requirement before a student can apply for graduation. Candidacy forms can be obtained through the Graduate College. Allow at least one semester for the form to be processed by the Graduate College and departmental graduate advisor.

**Thesis Proposals**

Students interested in pursuing either the library or research thesis options need to submit a thesis proposal for review and consideration by the department before they will be permitted to register for thesis credits. Potential topics are first discussed with a prospective thesis advisor to determine a project focus. The student drafts a proposal for review by the faculty advisor, which presents the background and scope of the project, hypothesis/hypotheses to be tested (question(s) to be addressed in the case of a library thesis), methodology (for research thesis only), anticipated timetable, and literature review. At the same time, in consultation with the research advisor, the student must form his/her thesis committee (thesis advisor + 2 additional Biology faculty members). If the proposal is acceptable to the thesis committee, it is then submitted to the Biology faculty for review and consideration. Faculty members are typically given a minimum of one week to provide comments and recommendations about the proposal. Students are required to have their proposal circulated to the department at least three weeks before the first semester in which they want/plan to register for thesis credits. The deadline for registering for thesis credits is the end of the first week of classes during a given semester. Check the current schedule of classes for specific dates.
Graduate Degree Time-Limit

Students in all Options have a maximum of 6 yrs to complete their degree. Students requiring an additional semester or more to complete their degree should petition the Graduate College and Biology Program, before the deadline is reached, to request an extension. Students taking more than 6 yrs may lose credits earned early in the program and may be required by the Graduate College to complete additional course work. Students not taking courses regularly (every year) may be dropped from the Graduate College.

Course Offerings

Only 400-level and a limited number of 300-level courses (maximum of 10 cr.; see below) can be applied toward the graduate degree.

Transfer credit: a maximum of 9 hours of transfer graduate credit can be applied to the requirements for the M.S. degree. The transfer credits must be approved by both the Graduate College and the Biology Department. Students interested in transferring credits need to submit official transcripts, a complete/detailed syllabus from the course(s), and rationale for transfer to the Graduate College. The petition form for transferring credits is available on the Graduate College web page. Following matriculation, students wishing to take classes at another institution and transfer the credits to NEIU must have the courses pre-approved by the Biology Graduate Advisor.

Courses from other NEIU departments: Students may have up to 9 cr. hours of course work taken in other departments counted toward their Biology degree. All course work from other departments must be preapproved by the Biology Graduate advisor. Students interested in taking courses outside the Biology Department should first check with the Graduate Advisor to determine if the course is acceptable towards a Biology degree; the student needs to then contact the Department offering the course to request permission to enroll in the course. Lastly, to be considered as part of the student’s degree requirements, the student must submit a written rationale for the course, as well as a copy of the course syllabus. This should be done no later than the first week of classes during the semester the course is taken.

300* Courses (can be taken for graduate credit; maximum of 10 cr. of 300* can be applied towards the credits required for the Biology M.S.)
BIO 358: Biological Geography
BIO 359: Ecological Methods
BIO 360: Vertebrate Physiology
BIO 361: Human Genetics
BIO 362: Biochemistry
BIO 363: Immunology
BIO 364: Endocrinology
BIO 365: Neurobiology
BIO 366: Cancer Biology
BIO 367: Developmental Biology
Portfolio Requirement - M.S. in Biology

Each student in the Biology graduate program will be required to assemble a portfolio of work that they complete during their tenure in the program. The portfolios will serve to (a) document the progress of each student toward the degree, and the skills and knowledge base that they have achieved by the end of their tenure, (b) provide students with materials that will help them reach their professional goals, and (c) provide the department with information that will allow us to assess the effectiveness of the program at achieving the goals and learning outcomes that we have established for the graduate curriculum.

Portfolios will be assembled on an ongoing basis, and will include examples of work from courses and work produced specifically for the portfolio. Examples of coursework will include multiple types of scholarly work completed by the student in NEIU graduate courses. Work specifically for the portfolio will be produced independently and will be for the purpose of achieving candidacy after the completion of 12 cr hrs of coursework or for being awarded the M.S. degree at the end of a student’s tenure.

Specific requirements for the portfolio will be provided by the department, but all portfolios will include:

(a) personal statements, reports of academic progress and/or self assessments written at different stages of completion of the degree requirements,

(b) curriculum vitae or resumes written at several stages of degree completion,

(c) representative examples of coursework (e.g., annotated bibliographies, summary/critiques of papers from the primary literature, poster presentations, supporting documentation for oral presentations, research proposals, review papers or research papers, and other examples of critical or synthetic writing).

For students who choose to complete the Research Thesis or Library Thesis option, the portfolio will include (in addition to the items in categories a, b, and c above) their approved thesis proposal and a copy of the final thesis manuscript.

For students who choose to complete the Non-thesis Option, the portfolio will include (in addition to the items in categories a, b, and c above):

(d) literature-based writing assignments in which students demonstrate their abilities to read, interpret, and synthesize information at a level expected of a graduate student in biology, and

(e) a short piece of writing that demonstrates a student’s ability to communicate their skills or expertise to either a professional or lay audience.

After submitting their portfolios, students will receive feedback on items in categories (a) and (b) from their faculty advisor, and the department will use materials in category (c) for the purposes of program assessment. The decisions to award candidacy or, later, the M.S. degree will be based exclusively on whether the student has met the requirements of the Graduate College and earns passing grades on items in categories (d) and (e); these items will be graded using common rubrics that are developed by the department and made available to the student in advance. Receiving a rating of “Acceptable” or better (out of the options of “Exceptional”, “Acceptable” and “Unacceptable”) will constitute a passing grade.

Candidacy:
In order to achieve candidacy, students must meet the Graduate College requirements for candidacy, submit a complete portfolio (as specified by the department), and earn a passing grade on a summary/critique that they write on an article chosen in consultation with their faculty advisor. The article must present original experimental research, be published in a peer-reviewed journal, and be no more than three years old. The summary/critique must be submitted no later than three calendar days after the student and their advisor have selected the paper. The advisor will evaluate the summary/critique and assign it a grade of “Exceptional”, “Acceptable” or “Unacceptable”, and then submit it to the
Graduate Program Committee for review. The committee can either accept the evaluation of the advisor, or consult with the advisor if it feels a different grade is warranted. If the grade is ultimately deemed to be unacceptable, the student will be denied candidacy and be cast from the program, but will be provided with an opportunity to appeal the grade to the entire tenure-line faculty in the department.

**Awarding of the M.S. degree (Non-Thesis Option):**

In order to earn the M.S. in Biology, students in the non-thesis option will be required to submit a portfolio of representative work and to receive passing grades on two pieces of writing, all of which are to be submitted at the beginning of the semester in which they apply for graduation.

Specific guidelines for the portfolio will be provided by the department, but the final portfolio should document both the final skill sets and knowledge base of a student as well as the academic maturation of the student.

In addition, each student in the Non-Thesis Option will write a short critical/synthetic paper and a short piece of professionally-relevant writing, each of which will be evaluated by the student’s faculty advisor and reviewed by the Graduate Program Committee. In order to be awarded the M.S. degree, the student must earn a grade of at least “Acceptable” on both of these assignments.

The synthetic paper will be based on two or three articles from the primary literature that are chosen by the student and their advisor, and must be submitted no later than seven calendar days after the articles are chosen. The paper will summarize the articles and discuss them both in relation to each other and in relation to the broader biological issues that they address. The paper will be evaluated on the bases of: organization, clarity, originality, the extent to which the student demonstrates a broad understanding of biology, the extent to which the student demonstrates a solid understanding of the particular subdiscipline addressed by the articles, the extent to which information from multiple sources is effectively integrated, and the overall quality of writing.

The second piece of writing that must be submitted should demonstrate that the student is capable of communicating effectively to a professional or lay audience, and might be: a statement of purpose that would accompany an application to a professional school or PhD program; a cover letter that would accompany an application for a biological job in industry, education or academia; an article about a biological issue that is written for the popular press; or another type of writing that the student and their advisor agree upon. This piece of writing will be evaluated on the bases of: organization, clarity, appropriateness of style for the intended audience, effectiveness at achieving the purpose for which it is written, and the overall quality of writing. In order to earn a passing grade on these assignments, each separate element evaluated must meet the criterion of being acceptable.

Both of these assignments must be done completely independently, and students will be required to sign an affidavit indicating that they have written them without input from any other individuals.

In order to be considered for graduation in any given semester, a complete final portfolio (including the two pieces of writing described above) must be submitted no later than the end of the second week of classes. Incomplete portfolios and portfolios submitted after the deadline will not be evaluated. The faculty advisor will evaluate the portfolio and submit their recommendation to the Graduate Program Committee by the end of the 7th week of the semester, and the committee will make their recommendation by the end of the 12th week of the semester. If the final portfolio is determined to be unacceptable by the Committee, the student can appeal the decision to the entire faculty, but must do so in writing and by the end of the 14th week of the semester. The department’s decision will be final.
Orientation, Indoctrination and Advising Schedules

Faculty Advisors:
Faculty advisor assigned at time of admission or by the end of the first semester of coursework. The advisor will meet with each advisee at least once per semester, help students plan coursework, ensure that items are being added to portfolio on a regular basis.

At the beginning of the semester in which a student applies for candidacy (after completion of 12 cr, but not more than 16 cr), select a paper for the summary/critique; grade paper and forward to Graduate Program Committee.

During the semester before a student applies for graduation, agree upon what the student will be doing for the piece of professional writing.

At the beginning of the semester in which a student applies for graduation, select papers for the synthetic paper. Grade papers, and forward recommendation to Graduate Program Committee; provide feedback to student about c.v. or resume.

Indoctrination activities:
Conduct an orientation session/workshop for all students in the grad program prior to the beginning of each regular semester. Review and explain all requirements of each option and timetables for satisfying the requirements.

Graduate Program Committee:
Committee of three tenure-line faculty members with a rotating membership (one member replaced each year). Meet at least once (and probably not more than twice) per semester. Responsibilities will include: reviewing applications for admission to the program, reviewing recommendations regarding students applying for candidacy, reviewing recommendations of students applying for graduation.