BIOLOGY 106
Fundamentals of Biology II
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Nature of this course

Biology 106 is the second semester of our year-long introductory course. Most of the people in the course are biology or wildlife majors, but several other majors require this course as well. Also, this course satisfies Core Curriculum requirements for a "depth" sequence in the Natural Sciences for any student. Biol. 105-6 is intended to introduce you to the nature of science as applied to living organisms. In Biol. 105, you studied the "big picture" parts of biology — ecology, evolution, biodiversity and mendelian genetics. In Biol. 106, we will look inside of life, contemplating the workings of cells and organisms.

Scientists have amassed an amazing amount of information about living systems over the centuries. It is tempting to "fill you full of facts" (in fact some of your previous experiences in science courses may have given you the impression that doing science is equivalent to memorizing facts and terms). Some understanding of concepts, facts, and terms is necessary for you to intelligently think about biology (and, for most of you, to progress to the next stage of your career in biology). Concepts, facts, and terms will largely be the provenance of the lecture portion of this course. We'll try to make learning these concepts, facts, and terms digestible (and even fun) by limiting the number of topics covered during the semester and by approaching topics from several perspectives. In the laboratory portion of the course, you'll be doing science. The laboratory portion of the course will consist of two major projects (as well as an introduction to some life-long skills early in the semester). In the first project, you will practice the knowledgeable use of science and the interaction of science and society. In the second project, you will do science; design an experiment, do the experiment, and write a scientific report and present a poster. Most scientific research these days is done by teams of scientists. You will also work in teams (doing science with other people is much more productive and fun than solo science).

Ways of Learning Biology

Traditionally, university-level introductory science courses (at least in the U.S.) consist of two parts: large group lectures (over one thousand students is common) and weekly two or three hour labs. Generally, lectures are just that - lectures, with understanding of material in lectures tested by periodic examinations comprised of "objective" (true-false, multiple choice, fill-in, matching) questions. Laboratories are traditionally "demonstrative," i.e., they are designed to provide a demonstration of processes described in lecture. The reasons for this structure are both practical and historical.

In recent years, the number of students majoring in biology (and related fields, e.g., health science) has increased dramatically in the U.S., presumably because of the increasingly important role that biology plays in our lives and economy. Simultaneously, most of higher education has been faced with decreased funding and inflationary increases in operating costs. Consequently, the large number of students taking introductory biology courses must be processed efficiently and large-group lectures and highly-organized demonstrative labs are a cost-effective means of doing business.
In addition to these practical considerations, there are cultural reasons why this large lecture/demonstrative lab format dominates introductory biology. Most faculty teaching biology “grew up” learning biology in this way and so feel comfortable teaching this way. Likewise, many students feel comfortable with (and some succeed at) learning via lectures and are able to memorize facts (at least long enough to do well on exams). Demonstrative labs have a satisfying compactness: you read the directions, do the lab, answer a few questions and you’re done for the week.

Finally, the growth of biological knowledge is increasing exponentially. There are so many topics and facts that could potentially be part of “basic biology” that many textbooks for major’s courses in introductory biology are well over 1000 pages. There is a temptation to “cover” as many topics as possible, in part to prepare you for further courses in biology and because many students feel that a “rigorous” course will be necessary to prepare them for professional careers in biology or medicine.

There are however, a number of problems with this “rigorous” lecture/demonstration lab format. The first is that lectures are of most use to verbal learners, but of less use to people who learn best via seeing (diagrams and images), reading and contemplation, or hands-on doing (manipulating real objects). The larger problem is that experience (and lots of studies) show that wholly passive learning (listening to a lecture - then recalling information) doesn’t work for many people and, even for those able to do well on examinations, such learning is generally short-lived. Trying to “cover” all or most of the potential topics of a general biology course of necessity means that each topic must be dealt with in short order. Finally, although knowing some basic concepts and techniques of biology is prerequisite to doing biology, learning facts and concepts isn’t how biology is done (in the same sense that knowing anatomy and physiology doesn’t make you a physician).

**Course Activities**

If the above material made you nervous — a dread feeling that we were going to try out some truly “off-the-wall” learning technique (e.g., Learning Biology via Jello Immersion) — don’t worry. However, we are going to incorporate some techniques for productive learning:

- provide some opportunities for active learning in lectures — providing a break from lectures and helping class members digest their new knowledge
- work in teams — you have lots to teach each other
- use videos in lectures — providing a feast for the visual learner and views of biology impossible from lectures
- do real science in the laboratories — where you (as part of a research team) design a study, ask questions, and deal with the uncertainty and joy of research

**Thinking About Biology (TAB)** assignments are to be taken home and savored. TAB’s are open book (use any resources you wish). The idea is to provide a non-stressful (i.e., not in a closed book lecture exam) format for you to think creatively and carefully about biology. Each TAB will include some straightforward “fill in the blank” type questions. In addition, TAB’s may have a short answer question or two, a biological puzzle or medical case history, a crossword puzzle, a “dry lab,” or you might be asked to create something.

**Lecture Exams** will also be multiple choice and will mostly (but not entirely) test lower-order thinking skills (knowledge and comprehension). You will receive a lengthy roster (“Test Bank”) of multiple choice exam questions before each of the two exams; questions on the exam will be drawn from this roster of questions.

**Laboratories** will have three phases:

- Transportable Skills workshops: Introduction to working in teams (small-group dynamics); Introduction to Science (asking questions of nature and the nature of data); Introduction to microcomputing (word-processing; data management; basic graphics)
• The DNA Project: DNA models; paper simulation of RFLP analysis; electrophoresis (simulation of forensic DNA testing); presentation of electrophoresis results; demonstration of an understanding of the techniques of forensic DNA testing (via answers to questions and small summary project)
• The Yeast–Biotech Project: introduction to yeast metabolism; team-designed experiment; production of research manuscript and poster presentation (for whole-class poster session at end of semester)

A few words about team research

You will do your two laboratory projects as members of a (generally 4 person) research team. We will work in teams for two entirely independent reasons. The first reason is that working in teams makes it logistically possible for us to do some real science in this large enrollment course. We can (just barely) provide space, supplies, equipment, and mentoring for 40 - 50 research teams; doing the same for 150-200 individual students is not possible. More importantly, nearly all science (and many other enterprises) is done these days by teams, so experience and training in working collaboratively is an important Transportable Skill (useful in many situations) for you to have packed in your suitcase. My experience is that the majority of teams work together very well. Those that don’t generally falter because one or more members is getting a free ride or because of disagreements or confusion about expectations. Rather than just putting groups of four students together and hoping for the best, we’ll provide a fairly structured system for your research teams. With a good will and effort on your part, I anticipate few problems.

Bloom’s classification of cognitive skills

“Bloom’s taxonomy” is a widely-used model of how we learn. Briefly, the idea is that we progress from the most concrete level (knowledge) to the most abstract level (evaluation):

• knowledge (remembering facts, terms, concepts, definitions, principles)
• comprehension (explaining/interpreting the meaning of material)
• application (using a concept or principle to solve a problem)
• analysis (breaking material down into its component parts to see interrelationships/hierarchy of ideas)
• synthesis (producing something new or original from component parts)
• evaluation (making a judgment based on a pre-established set of criteria)

This is any introductory course so it is fitting that we should work mostly (but by no means entirely) at the lower levels (knowledge, comprehension, application) of cognitive skills. Lecture exams will mostly test the “knowledge” and “comprehension” levels, TAB’s the “comprehension” and “application” levels and the lab projects the “application” through “synthesis” levels.

Text

The required text is the same as used last semester:


Note that this text will be used as reference material:

• for writing up take-home “Thinking About Biology” assignments
• for preparing for lecture exams
• for writing up laboratory projects
• for your use in gaining another perspective on material presented in lectures and labs.
Grades

Your final grade will be based upon performances in weekly (more or less) Thinking About Biology (TAB) assignments, Lecture Exams, Research Projects, and effective participation in the laboratories. The distribution of points is as follows:

<table>
<thead>
<tr>
<th>activity</th>
<th>#</th>
<th>@</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAB’s</td>
<td>8 (best 8 of 11)</td>
<td>50</td>
<td>400</td>
</tr>
<tr>
<td>Exams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshops write-up</td>
<td>1</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>DNA lab project</td>
<td>1</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Yeast-biotech lab project</td>
<td>1</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>total for class</td>
<td></td>
<td></td>
<td>1000</td>
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</table>

There are possibilities for extra credit as follows (details later via separate handout - contact Oswood)

<table>
<thead>
<tr>
<th>activity</th>
<th>maximum points each</th>
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<tbody>
<tr>
<td>Virtual Reality Laboratories via the Web</td>
<td>25</td>
</tr>
<tr>
<td>read article in Discover or Scientific American magazine - prepare summary (specific format required)</td>
<td>25</td>
</tr>
<tr>
<td>view Howard Hughes Medical Institute (HHMI) “Holiday Lectures” series (4 1h videos each topic) - take exam over topic</td>
<td>50</td>
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</tbody>
</table>

Final grades will be based upon the % obtained of the total possible points, as follows:

A ≥ 90%
B ≥ 80%
C ≥ 70%
D ≥ 60%
F < 60%

A few words about grades, teaching, and life

Many people perceive teaching as a sort of mental mid-air refueling; a teacher pours “stuff” down a mental pipe into the minds of students and each student’s mind fills up more with each class (hopefully “topped off” by the end of a degree program). It doesn’t really work this way. Everyone learns by constructing new knowledge for themselves. Our job is to help you do this by providing good opportunities to learn and by helpful coaching. What you take out of this course (or any other course – or life) will depend on what you put into it.

Ultimately, your entire life is a sort of final exam. However, we need to provide a letter grade for each of you in this course. We’ll try really hard to have this grade be a good measure of your learning. Please keep the following in mind:

- grades on an individual assignment, exam or even an entire course are an estimate of your learning. Such estimates are inherently imprecise but hopefully the variance is relatively small. It will always be the case that you will “win a few and lose a few” but it will all “wash out” in the end. For example, the assignment (or exam – or course) in which you get a’’ C+ — almost a B-’’ (argh!! not fair - so close!) — will, over the long haul, be balanced by the assignment (or exam – or course) that you barely squeak into a B- (whew!).

- If you are just starting your college career, the different expectations of college courses may come as a rude surprise. Naturally, the standards are generally higher for college classes than for high school classes and this takes some adjustment. Many high school classes are highly structured affairs, with a good part of the course grade based upon (many) small assignments with very clear
expectations. Students often succeed in these courses by making a good-faith effort to “do the work.” In contrast, most college courses will require at least some success in the higher level skills of Bloom’s taxonomy (recall above) and this often causes some anxiety or anger (“just tell me what you want!”). Take heart - it’s all part of gaining the tools to be a life-long learner.

- Your grade on any assignment or exam or course is hopefully a reasonably fair assessment of your performance in the assignment or exam or course. None of these are any assessment of any other aspect of your life (of which academia is only one part) and certainly not a measure of your worth as a human being. Keep things in perspective.

Attendance at laboratories is essential, in part because the laboratory is the yang (doing science) to the yin (concepts, facts, and terms) of the lecture part of the course. Further, you will be working in teams in the labs and being chronically late or absent places an unfair burden on your team members. Each team will meet regularly and each team member will have a clearly defined role in the group enterprise. Progress of the group and each group member will be monitored by minutes of group meetings and by assessments by the Teaching Assistants. Students not able to regularly attend labs and participate with their team in carrying out research projects will receive an Instructor-Initiated Withdrawal from the course, regardless of scores received on TAB’s or lecture exams. Also, ineffective participation as a member of a laboratory team may well result in other team members electing to delete you from the list of authors of a lab report (score = zero for that report). If you know at the outset of the semester that there are unavoidable conditions of your life that will make it difficult for you to participate fully in group research (e.g., chronic illness of you or a dependent) let’s talk at the very beginning of the semester.

Late Policy

In spite of good intentions, life is complex and sometimes hard: cars don’t start, kids get sick and have to stay home from day care, people get the flu. However, excuses for late work range from really good (“I was having open heart surgery”) to really bogus (“I was tired and just couldn’t seem to get out of bed”). In a class of this size, dealing with late material becomes a logistical nightmare. What’s more, we don’t want to spend time and energy judging the “goodness” of excuses for late work; we’re all adults and this sort of thing is beneath our collective (yours and ours) dignity.

So, we’ve “built in” considerable flexibility to the scoring system.

- You will note that your score on TAB’s is “best 8 of 11.” No late TAB’s will be accepted (even minutes late) and the score for a TAB not received in time will be zero. Obviously, you can miss three TAB’s with no effect on your final grade (although “using up” your three dropped scores as “no shows” means that you have no opportunities to drop the lowest scores on TAB’s that you did submit).
- The cell & molecular biology exam (exam 1) can be taken up to 3 days late with a signed Late Exam form
- The anatomy and physiology exam (exam 2) will be given during the Final Exam period. This exam must be taken during the final exam period because final grades are due shortly after final exams. However, an Incomplete is possible for students missing exam 2 so long as the requirements for receiving an “I” are met (unable to complete course because of factors beyond reasonable control of student; grade of “C” or better on work to date).
- There are possibilities for extra credit, as outlined above

Special arrangements can be made for documented long-term illness (of you or an immediate family member) or for major emergencies.

Academic Dishonesty

In 21 years of “professoring,” I’ve had very few close encounters with academic dishonesty. I think that most people are honest. Please read the UAF Honor Code (page 18 of the 1997-8 UAF Catalog). Academic dishonesty is bad news for everyone; damages your soul (and possibly your career) and makes
life absolutely miserable for your teaching staff. If you're caught, we'll have no choice but to present the case to the University Disciplinary and Honor Code Committee.

TAB's are intended to provide some relief from the "memorize and regurgitate" mode of instruction common to large-enrollment introductory courses. The rules for TAB's allow people to use any resources they wish (no "closed book" memorization necessary) and even allow people to work together and co-author a TAB. However, the rules explicitly do not allow copying of answers among TAB submissions. Answers that are identical (or nearly so) clearly violates both the letter and spirit of the TAB rules. Please be absolutely certain that you (or you and your co-authors) submit TAB's that are independently written.

Schedule

A schedule of activities and due dates is provided on the next page. This schedule is subject to change (with reasonable notice): even with a class of this size, we need the flexibility to make mid-course corrections and deal with unpredictable events.
<table>
<thead>
<tr>
<th>week of</th>
<th>lecture topic corresponding chaps in Audesirk and Audesirk in brackets</th>
<th>lab</th>
<th>due dates (all TAB’s due in class on Tues)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Jan</td>
<td>Intro to Course (15 Jan start of semester)</td>
<td>no lab</td>
<td></td>
</tr>
<tr>
<td>19 Jan</td>
<td>Chemistry of life [2,3]</td>
<td>Lab safety; form lab teams; Intro to collaborative learning and team research</td>
<td>TAB 1 (Chemistry of life)</td>
</tr>
<tr>
<td>26 Jan</td>
<td>Cells [5,6]</td>
<td>Workshop: Asking questions of nature and the nature of data</td>
<td>TAB 2 (Cells)</td>
</tr>
<tr>
<td>2 Feb</td>
<td>DNA [10]</td>
<td>Workshop: Intro to microcomputer applications</td>
<td>TAB 3 (DNA) workshop write-up due</td>
</tr>
<tr>
<td>16 Feb</td>
<td>Biotechnology [14]</td>
<td>DNA Project: electrophoresis</td>
<td>TAB 5 (Biotechnology)</td>
</tr>
<tr>
<td>2 March</td>
<td>Respiration [8]</td>
<td>Yeast–Biotech Project: getting to know fermentation (it's the yeast you can do)</td>
<td>DNA Project Write-up due</td>
</tr>
<tr>
<td>9 March</td>
<td>10 March cell/mol. biol. exam; 12 March Homeostasis and organ systems [29]</td>
<td>research team meetings --&gt; research proposal for Yeast–Biotech Project</td>
<td></td>
</tr>
<tr>
<td>16 March</td>
<td>Spring Break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 March</td>
<td>Respiration [31]</td>
<td>Yeast–Biotech Project: research team meetings for data analysis/writing</td>
<td>TAB 8 (Respiration) Yeast–BiotechProject: Draft paper due</td>
</tr>
<tr>
<td>6 April</td>
<td>Nutrition and digestion [32]</td>
<td>Yeast–Biotech Project: research team meetings for data analysis/writing</td>
<td>TAB 9 (Nutrition and Digestion)</td>
</tr>
<tr>
<td>13 April</td>
<td>Excretory system [33]</td>
<td>Yeast–Biotech Project draft manuscripts returned: research teams begin work on research poster</td>
<td>TAB 10 (Excretory System)</td>
</tr>
<tr>
<td>20 April</td>
<td>Immune system and disease [34]</td>
<td>Yeast–Biotech Project: research team meetings complete manuscript and poster</td>
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<tr>
<td>27 April</td>
<td>Poster Session 28 April 30 April = wrap-up and SOI</td>
<td>no lab (present poster in Poster Session during lecture time)</td>
<td>TAB 11 (Immune System) Yeast–BiotechProject: Final paper and poster due 28 April</td>
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<td></td>
<td>anatomy and physiology exam</td>
<td></td>
<td>8-10 AM Thursday 7 May (final exam period)</td>
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