Department: BIOL

Course No: 102

Credits: 4

Title: Foundations of Biology

Contact: Kentwood D. Wells

Content Area: Grp 3 Science and Technology

Catalog Copy: BIOL 102 . Foundations of Biology. Either semester. Four credits. Three class periods and one 2-hour laboratory period. Not open for credit to students who have completed a year of advanced biology in high school. Students may not receive more than 12 credits for courses in Biology at the 100's level.
A laboratory course designed for non-science majors; surveys major biological principles with emphasis on their importance to humans and modern society.

Course Information: BIOL 102 is a non-majors' survey course that provides a general introduction to concepts and principles of biology. The course goals are: 1) to furnish an overview of contemporary biological science; 2) to present students with hands-on learning (observation and experimentation) in a laboratory setting; 3) to illuminate concepts and fields of biological research that are relevant to an informed citizenry; 4) to teach skills useful in evaluating media reports on biological topics.
The course requires that students average passing grades on three in-class hour exams and one final. Depending on the instructor, these exams range from 40-100% multiple choice. Exams that are only part multiple choice also include short essays requiring some synthesis of lecture material and interpretive questions based on data presented as numbers, graphs and diagrams. For most instructors, reading assignments (approximately 1-2 Chapters per week of the text book) are treated as supplementary to the lecture material. The laboratory component comprises between 25 and 33% of the final grade, depending on the instructor, and is evaluated on the basis of quizzes, written problem sets and exercises, and lab reports.
Content generally includes: Biology as a Science (hypothesis generation and testing); Chemical basis of life; overview of metabolism (respiration/photosynthesis); overviews of Mendelian and molecular genetics; biological diversity; basic plant biology (form and function); basic animal biology (form and function); concepts of ecology (populations, ecosystems); human impacts on ecosystems; concepts of evolutionary biology.

Meets Goals of Gen Ed: BIOL 102 is proposed as a course to be included in the Science and Technology Content Area.

General Education Purposes
Goal 2. *Intellectual breadth and versatility* . BIOL 102 provides a perspective on the complexity and diversity of living organisms, and the importance of non-human organisms to the functioning of ecosystems. In addition, it investigates issues of general relevance in human biology. For most students taking BIOL 102, it will be their only experience with the science underlying ecological, genetic and

biomedical issues they will confront in their daily lives.
Goal 3. *Acquire critical judgment* . This goal is addressed in two ways. The laboratories in BIOL 102 are designed to acquaint students with the *process* of science – formulation and testing of hypotheses, and acquisition and interpretation of data. Students collect their own data, evaluate the fit of the data to a hypothesis, and graphically present and interpret their results. Lecture content integrates current topics, again emphasizing hypothesis generation and testing, and explanation of how to interpret media reports (e.g., genetically modified crops, global warming, genes 'for' diseases)
Goal 7. *Acquire a working understanding of the processes by which they can continue to acquire and use knowledge* . By emphasizing the scientific process, both the laboratory and lectures call attention to the reality that Biology is a dynamic, not a static science – no 'fact' is necessarily immutable, and any observation can be further tested or reevaluated in the context of new data. This approach seeks to demystify science by clarifying the roles that the single scientists play, the same roles that any individual may adopt during their lifetimes.

CA3 Criteria:
1. *Explore an area of science by introducing students to a broad, coherent body of knowledge* . **Biology** 's coherence is provided fundamentally by the genetic materials shared by all living organisms – the nucleic acids DNA and RNA. In addition, living organisms share basic features of cellular organization. These basics provide the springboard for instruction in cellular metabolism, genetics, organismal diversity, ecology and evolution.

2. *Promote an understanding of the nature of modern scientific inquiry and the process of investigation* . As described above (Goal 7), BIOL 102 has a strong focus on the scientific process. The laboratories in BIOL 102 are designed to acquaint students with *process* – forming hypotheses, testing them through the design of methodical observation or experimentation, and finally the interpretation of the data that are acquired. Lectures often emphasize the scientific process by detailing particular stories of discovery (e.g., immunity and smallpox, DNA and proteins, endosymbiosis). Current topics are also presented in this context: how are hypotheses (e.g., global warming or evolutionary relationship) tested?

3. *Introduce students to unresolved questions and discuss how progress might be made in answering these questions* Students are quite often presented with unresolved questions in biology. When these questions arise, the reasons why we do not know, as well as what we need to do to gain an answer, are discussed. These issues are often illuminated by discussion of the meaning and importance of new discoveries.

4. *Promote interest, competence, and commitment to continued learning about contemporary biology and its impact upon the world and human society* **.** Interest, competence and commitment to continued learning are promoted by instructors who are personable, respectful of students and excited about Biology. As a non-majors course, BIOL 102 seeks to engage students by presenting principles and concepts via relevant examples – i.e., current topics or issues of human health and ecology.

CA3 Lab Criteria: There are 13 two-hour laboratories each semester. The sequence of labs, and occasionally the content, may vary depending on the instructors. The lab manual, " *Hands on Biology* " is geared to experimentation and student participation. Student evaluations indicate that the labs are considered a course highlight. A lab report is required for each lab. In addition, 12 quizzes are administered. An optional comprehensive practicum is offered at the end of semester.

Week 1. Microscopy & Cell Diversity.

Part 1: Microscopy. Students learn to use both dissecting and compound microscopes; they are taught how to calculate magnification and about resolving powers of the two scope types. They work with specimens, prepare a wet mount (slide) and stain the tissue, and draw three of the specimens that they have observed. They must turn in a lab exercise based on the lab.

Part 2: In the second part of the lab, they examine and sketch both animal and plant cells. Each student is responsible for making and drawing a plant (*Elodea*) and animal (human cheek) cell. They use methylene blue to stain their cheek cells. They also perform an experiment using dialysis tubing to simulate osmotic movement of fluids across a cell membrane. There is one demonstration: they examine the gut symbionts of a termite. A written exercise, with several of their original drawings, must be completed.

Week 2. Enzymes. This exercise helps students learn how enzymes, quintessential proteins in metabolism, function. Initially, they use catalase to break down hydrogen peroxide into water and oxygen. Then they test for catalase activity in potatoes. They spend a good portion of the lab working with their samples and measuring the amount of oxygen produced. The students then graph their results. The experiment is repeated under two additional temperature and four pH regimes--the activity of enzyme (catalase) is measured as function of the amount of oxygen produced. Each student must prepare three graphs and answer several questions.

Week 3. Cell Division. In this lab the students learn about mitosis and meiosis, reinforcing material presented in the lecture. The students prepare their own slides (including staining the tissue). For animal tissues (whitefish blastula) they examine prepared slides. Each student makes ten original drawings. Working with a lab partner, the students simulate meiosis and mitosis by making chromosomes out of beads and then "reproducing." In the final part of the exercise they get images of human karyotypes and they are asked to diagnose the unknown individual as to whether the individual is normal or suffers from Down, Klinefelter, or Turner's syndrome. Upon completion of the lab the student must turn in a lab exercise.

Week 4. Genetics. This lab is a favorite, in part because the students learn a good deal about their own genotypes and have hypothetical families. They start off by working through several Punnett Square problems. They then are given an ear of corn and asked to work out the Mendelian genetics of the "purple-seed" trait. Working with a lab partner they determine their own genotype for 12 traits: ability to curl tongue upward, ability to curl tongue under, attached or free ear lobe, hitchhiker's thumb, etc. They then work with human blood (purchased from a biological supply house) to determine the donor's blood type. They prepare slides using anti-sera to determine the unknown individual's blood type. Strict lab protocols are enforced. (All blood is screened and guaranteed to be free of infectious diseases.) They finish the lab by pairing up with a partner and making predictions about the probable genotypes of their "potential future children." They must turn in a lab exercise based on the exercise.

Week 5. Gel Electrophoresis & DNA Extraction. In this lab the students are introduced to modern DNA genetic and forensic techniques using "simulated DNA samples." The students prepare their own agarose gels, load DNA into the gel, run the samples through an electric current, stain the gel, and then interpret their results. They run six samples from six suspects and try to match to DNA evidence left at a

crime scene. In the second half of the lab they work with restriction enzymes and RFLP (restriction fragment length polymorphisms). Students complete and turn in a short lab exercise.

Week 6. Evolution. Evolution is the cornerstone of biology and a principal theme in the course. This lab is meant to reinforce points made in lecture and give students first-hand exposure to the evidence for both micro- and macroevolution. The lab begins by each student simulating natural selection via a computer software program on evolution in pepper moths. Then the class works on an exercise together—each student becomes a lizard for 20 minutes, their genotype determined by a chance draw from beads in a paper bag. The students "mate with each other at random" for four generations. Then the class simulates selection against one of the alleles for four additional generations and contrasts gene frequencies under the random mating regimen to those resulting from four generations of selection. They are required to graph changes in allele freq. over four generations. In the second half of the lab they work with fossils, the geological time scale, and see examples of vestigial structures in vertebrates. Students must turn in a lab exercise.

Week 7. Plant Diversity. The lab highlight is a greenhouse tour through the University of Connecticut's living plant collection. EEB maintains the finest university plant collection in the Northeast—a state-of-the-art research greenhouse facility. The students learn about convergent evolution, pollination syndromes, and seed dispersal. This lab, more than any other, involves demonstration material. They draw some of the things that they observe and fill out a lab exercise.

Week 8. Invertebrate Diversity. The lab involves a lot of demonstration material—Karen Lombard essentially builds a mini-natural history museum/aquarium/zoo. Students make slides of sponges and draw their structure, examine prepared slides of other invertebrates, make observations on live planarian, dissect a clam, and examine preserved specimens of a grasshopper. They are given several unknown invertebrates and use a lab key to identify each to phylum. An optional exercise, a "phylum hunt," is an added exercise for students who want to add points to their lab grade. This part of the exercise is modeled after a scavenger hunt; the students are encouraged to cast their "net" widely (for example, by taking visits to a pet store or fish market) to find as many phyla as possible. Digital (original) images are accepted. Students turn in a lab exercise.

Week 9. Cardiovascular System. This is a fun lab where the students get to measure their own blood pressure and administer an ECG. They work with a model (human) heart to better understand blood flow in their bodies. They do not actually work with human blood—all microscopy involves prepared slides. A lab write up is required.

Week 10. Sensory Perception. This is one of the more hands-on labs and a perennial favorite. The students learn a great deal about their own sensory abilities by working through a number of tests that measure their own abilities to see, taste, smell, hear and touch. Most of the exercises pair up students into teams. Working with a partner they dissect a sheep eye and identify many of the macroscopic structures common to vertebrate eyes. A lab write up is required.

Week 11. Animal Behavior. In this exercise the students work with live pillbugs and Siamese fighting fish. Initially, students record the movements of pillbugs that are given a choice between dry and moist filter paper. Then using pillbugs they are asked to design their own experiment. They are encouraged to test for effects of temperature, light, moisture, or shelter, or anything else they can design with their TA.

They then work with male betas—each confined to a separate mini-aquarium. Students contrast the behaviors of fish not exposed to other males versus their behavior when a male is brought into close proximity (two aquaria are moved alongside one another). Students must submit a written worksheet based on the lab. This is a great lab—many of the students request to take the betas (fighting fish) home as pets upon completion of the labs.

Week 12. Field Ecology. This is one of our most unique and difficult labs--it requires students to be creative and think independently, and most importantly, ask questions. A second goal is to get students outside. The lab begins with a walk, where the TA introduces them to various ecological phenomena, the local communities, and several of the common plants and animals in the area. During the walk they are taught about making observations, posing questions about why things are the way they are, making hypotheses, and then devising experiments that might be used to test their hypotheses. They don't collect data—but simply learn how to pose questions and design experiment/test hypotheses. Their exercise is simply to write down 10 questions about nature—many struggle, but somehow we all survive. For the second part of the lab we visit a pond on campus and collect data on water temperatures, pH, turbidity, phosphate, dissolved oxygen, etc. They also collect water samples and study the pond life under microscopes in the lab. Students must complete a written exercise and turn it in at the end of the lab.

Week 13. Environmental Biology. In this lab the students play a dice game which teaches them about over fishing in New England and the "tragedy of the commons." Half of the students harvest and eat as many goldfish (crackers) as they can, based on the rolls of the dice. The other half of the class harvest only "sustainable" numbers of goldfish. The long term pitfalls of harvesting as much as you can catch are usually clear after four or five rounds of the game. In the end the students see, first-hand, how yield over the long term is greatly enhanced by acting in a sustainable fashion. In the second part of the lab they examine aquaria that have been exposed to different acid rain regimes. The students measure pH and make slides of the pond life growing in each of three pH regimes. The lab concludes with a series of calculations that the students must complete to predict how much energy and natural resources they might use as an American consumer over their lifetime. Drawings (of pond life) and written worksheet must be completed.

Role of Grad Students: Graduate TAs teach all laboratory sections, with two TA's per section (except at Regional campuses). Supervision is by a laboratory coordinator and/or instructors in the course. TAs are required to attend weekly meetings in which all aspects of the upcoming labs are discussed by the coordinator and instructors. New TA's are required to attend teaching workshops offered to all incoming teaching assistants in the university.