The Ohio State University
Colleges of the Arts and Sciences New Course Request

College of Biological Sciences

Academic Unit
Biology

Book 3 Listing (e.g., Portuguese)
402 Integrated Biology II

Number Title
IntegratdBiologyII U 5

18-Character Title Abbreviation Level Credit Hours

Summer Autumn Winter Spring x Year 2008

Proposed effective date, choose one quarter and put an "X" after it; and fill in the year. See the OAA curriculum manual for deadlines.

A. Course Offerings Bulletin Information

Follow the instructions in the OAA curriculum manual. If this is a course with decimal subdivisions, then use one New Course Request form for the generic information that will apply to all subdivisions; and use separate forms for each new decimal subdivision, including on each form the information that is unique to that subdivision. If the course offered is less than a quarter or a term, please complete the Flexibly Scheduled/Off Campus/Workshop Request form.

Description (*not to exceed 25 words*): A case studies approach is used to to gain a better understanding of biological

concepts and principles. This course is designed for biology majors.

Quarter offered: Sp, Wi Distribution of class time/contact hours: 2 1.5 hr cl, 1 1hr rec

Quarter and contact/class time hours information should be omitted from Book 3 publication (yes or no): yes

Prerequisite(s): 401; and Chem 123; and Math 150; or permission of instructor

Exclusion or limiting clause:

Repeatable to a maximum of _____ credit hours.

Cross-listed with:

Grade Option (Please check): Letter ☐x S/U ☐ Progress ☐ What course is last in the series?

_____

Honors Statement: Yes ☐ No x GEC: Yes ☐ No x Admission Condition
Off-Campus: Yes ☐ No x EM: Yes ☐ No x Course: Yes ☐ No x
Embedded Honors Statement: Yes ☐ No x

Other General Course Information:

(e.g. "Taught in English." "Credit does not count toward BSBA degree.")

B. General Information

Subject Code 260101 Subsidy Level (V, G, T, B, M, D, or P) B

If you have questions, please email Jed Dickhaut at dickhaut.1@osu.edu.

David Horn

5. **COLLEGE CURRICULUM COMMITTEE** **Printed Name** **Date**

10-29-07

6. **ARTS AND SCIENCES EXECUTIVE DEAN** **Printed Name** **Date**

7. Graduate School (if appropriate) Printed Name Date

8. University Honors Center (if appropriate) Printed Name Date

9. Office of International Education (if appropriate) Printed Name Date

10. **ACADEMIC AFFAIRS** **Printed Name** **Date**

Colleges of the Arts and Sciences Curriculum Office. 10/02/06

Biology 402: Integrated Biology II U **5 credit hours**
Spring quarter, 2008

Course description: Biology 402 is the second course of a two-quarter sequence that uses case studies to illustrate and explore fundamental concepts of the biological sciences. The two-course sequence provides a solid foundation and preparation for any major in the biological sciences. *This syllabus is one possible adaptation of the second course in the series; in future iterations, modules may be exchanged, but the goals and objectives of substituted modules should align with the goals and objectives of the modules they replace.*

Prerequisites: Biology 401; and Chem 123; and Math 150; or permission of instructor

Lecture time: 2 x 1.5 hours
The first year clientèle for this course will consist of current biology majors who are opting into the redesigned major – very few Au07 freshmen will be ready for this course. We plan to cap the initial enrollment at 100 students. In 2008-09, we plan to limit course enrollment to appr. 250 students per offering. At that class size, offering this course twice a year should be adequate to accommodate all new biology majors.
Faculty instructors:
Contact information:
Office hours:

Recitations: 1 x 1 hour
The recitations incorporate learning activities that are designed to be applicable to any module substituted in the course and will be capped at 15-20 students per recitation. One GTA should be able to handle 4 recitation sections.
GTAs:
Contact information:
Office hours:

Course Coordinator:
Staff member, coordinates lecturing assignments, lecturer training workshops, recitation activities and GTA training, maintains list of seminar options, and coordinates student assessment activities.
Contact information:
Office hours:

Course objectives: Students will continue to apply and explore in greater depth facts and concepts already learned in introductory biology courses. They will continue to develop the ability to integrate biological information and ideas, to apply foundational unifying theories to new problems or situations and to demonstrate quantitative skills that are central to study and research in the biological sciences.

Learning goals:
1. Students will apply facts and concepts related to the following overarching themes to analyze biological phenomena:
- The cell
- Heredity
- Emergent properties
- Regulation
- Interaction with the environment
- Diversity
- Evolution
- Structure and function
- Scientific inquiry
- Science/technology and society
- Fundamental interconnectedness of chemistry, physics, mathematics
- Metabolic unity

2. Students will use quantitative skills, concepts from the physical sciences, and overarching biological themes (listed under #1 above) to analyze biological phenomena.
3. Students will integrate at least two overarching themes (listed under #1) to explain a complex biological system.
4. Students will increase their scientific literacy as they demonstrate critical thinking and scientific logic in the analysis of natural phenomena and the ethics behind the human involvement in these phenomena.
5. Students will gain the ability to identify the components of a scientific study and analyze the validity of the methods and results.
6. Students will increasingly value the study of biology and begin to see their role as a biologist in society, business, industry, and health fields.
7. Students will analyze application of their own learning style to best study biological content and procedures.

Readings: Reading materials for this course will be varied. A course packet will be available at CopEZ and additional materials will be available on the course web site. In addition, every student will be expected to have available a rigorous introductory biology textbook targeted to science majors to use as a reference book. Campbell's *Biology*, 7th edition, is recommended for the reference work.

Grading:

On-line assignments and recitation activities — 30 points

A series of graded activities with varying deadlines will be placed on the course web site. You will be expected to check this web site on a daily basis and to complete those assignments by the indicated deadlines. Some of these assignments will involve answering questions that will be similar to questions on the midterm and final examinations.

Midterm — 20 points

Paper — 10 points

Write a summary article, as if for the summary articles in *Science* or *Nature*, describing the topic presented by one of the approved seminar speakers (list of approved seminars is attached, and will be updated over the course of the quarter). Your paper should summarize the experimental methods and results, including a discussion of model system(s), if appropriate, and an analysis of variables that were considered (or not) and limits in interpretation of the data presented. You should compare the guest lecturer's presentation with related work by other biological scientists.

Attendance and participation 10 points

Attendance will be taken during recitation and in lecture. Participation will be evaluated in recitation. Every absence must be excused by the Course Coordinator. Absences due to official university-sanctioned events or (documented) illness of the student generally will be automatically excused; other excuses will be reviewed on a case-by-case basis.

Final exam 30 points

>90% A
81-90% B
71-80% C
61-70% D
<61% E

Academic Misconduct:
It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee on Academic Misconduct (Faculty Rule 335-5-487). For additional information, see the University's Code of Student Conduct (http://studentaffairs.osu.edu/resource_csc.asp).

Disability Services:
Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the Course Coordinator as soon as possible of their needs. The Office for Disability Services is located in room 150 Pomerene Hall, 1760 Neil Avenue; telephone 614-292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/.

Weekly schedule of lectures and assignments:

Module 1: Model systems as a tool in biology

This module is designed to introduce students to common model systems used in genetics, cellular and molecular biology, and ecology. Students will gain an understanding of how biologists use model systems and how information from one model system can (or cannot) be extrapolated to other organisms.

Lecture 1

Why scientists use models.
How do biologists dissect complex processes?
Why don't people work on elephants and fleas?
Why do we choose the models that we do?

Recitation 1:

Examine specimens of model systems: Zebrafish, Arabidopsis, C. elegans
What do we want in the "ideal" model system?
Suppose the problem is an ecological problem, how do you establish system – model communities
Recitation assignment: Position paper: Explain why research on a particular model organism should be funded (i.e. what are the strengths of this model organism).

Lecture 2

Brief description of standard (genetic) model systems
Historical perspective + tools available in systems chosen + complexity
Stengths of different systems… disadvantages of certain model systems
Escherichia coli
Saccharomyces cerevisiae (yeast cell cycle – insights about cancer)
(Neurospora crassa)
Chlamydomonas reinhardii
Zea mays
Arabidopsis thaliana
D. Dictyostelium
C. elegans
D. melanogaster
Zebrafish
Mouse
Mathematical models
Systems biology

Module 2: Development of multicellular organisms: are we really like a fly?

This module will reinforce basic concepts of the cell cycle and genetics as students explore related examples of development in different model systems. The focus will shift from the roles of hox genes and segmentation in Drosophila to the roles of hox genes in mouse, and will conclude with a discussion of the entirely different mechanisms of plant *development and organ formation. The module will conclude with a discussion of the genetic basis of behavior.*

Lecture 3
How do multicellular organisms organize themselves?

Discuss regulation of the cell cycle (tie in to *S. cerevisiae* discussion from Module 1). Present *Dictyostelium discoideum* development and the mechanisms by which single cells aggregate and form a multicellular organism. Discuss the central themes of development: patterning, cell fate specification, differentiation, cell-cell interactions, gastrulation and organized cell movements.

Recitation 2:
Turn in position paper supporting funding of a model organism.
Who funds science, what is "responsible" science?
Discuss the weaknesses of the model system you proposed in your paper – why is it important to fund research using more than one model organism?

Lecture 4
How do we understand how this complex process of development works?

Describe the approaches of classical embryology. What was learned and what are the limitations? Discuss the limitations of biochemical approaches in 'reconstituting' development. Focus on genetic approaches to dissecting development. Describe loss-of-function and gain-of-function mutations, forward genetic screens, and genomic-based approaches to development.

Lecture 5
Why do wings normally form on the thorax and antennae on the head of a fly?

Describe the pathways that pattern the Drosophila embryo. Discuss maternal versus zygotic regulation. Present the cascade of segmentation genes that define the appropriate number of segments. Describe homeotic (Hox) genes and their role in specifying segmental identity.

Recitation 3:
Examine Burgess shale fossils – speculate about development of some of the more unusual organisms; what is similar to extant living organisms? Propose mechanisms for the development of the body plan exhibited by these unusual organisms.
Examine how diverse forms can result from single mutations
Morphological structures – diversity of forms – molecular diversity—classification of organisms
Classical classification systems based on morphology; now can be more closely defined based on molecular changes

Lecture 6
Are Hox genes conserved in other animals?

Discuss the conservation of developmental pathways focusing on Hox genes. Present Hox gene complexes and Hox gene function in mouse. Are Hox genes found in unsegmented animals like Hydra? Discuss the role these developmental regulatory genes play in specifying the diversity of body plans using arthropods as an example.

Lecture 7
How do cells interact with each other during development?

When and why do cells need to interact with each other during development? Present a cell signaling pathway that is important in development (the Hedgehog or Wnt signaling pathways could be used as examples). What are the components of a signaling pathway (ligands, receptors, cytoplasmic signaling proteins). Discuss how these signaling pathways are used multiple times in development and disease.

Recitations 4 and 5:
Choose one disease from the suggested list of human genetic diseases. Work in small groups to find background information and prepare a 10 min presentation about that disease. What are the symptoms; what gene (or genes) is affected; what is the most common mutation(s) giving rise to the disease; how can you explain the symptoms in terms of the mutation; how can the disease be treated; how is the disease being studied (model organisms)? Recitations 4 and 5 are reserved for the groups to present their results.

Lecture 8
What are the similarities and differences in plant and animal development?

Discuss the differences between plants and animals. Address whether common regulatory pathways are conserved in animal and plant development. Are the same developmental paradigms used? Are the same types of proteins used for development in these different kingdoms? What plant models are used to study developmental mechanisms? Early patterning of the Arabidopsis embryo and homeotic genes regulating flower patterning could be a focus.

Lecture 9
What is the genetic basis for complex behaviors?

Discuss how the same approaches that have been used to understand development can be applied to complex behaviors, including learning and memory. How have learning and memory been dissected in an invertebrate model system like Drosophila or *C. elegans*? Describe how the genetic screens were done. Discuss some of the genes that were identified and the nature of these gene products. Extend the role of these genes in vertebrate learning and memory. Alternatively, other complex behaviors (e.g. circadian behavior) could be discussed.

Module 3: Tropical Wet Forest Ecosystem Diversity
Students will examine the evidence for the loss of biodiversity in the context of the systems from which this evidence was obtained.
(7 lectures, 3 recitations)

Lecture 10
What is tropical forest?
Introduction of tropical climates (sun, water, atmosphere and topographic effects).
Distinguish the three levels of biodiversity - examples from tropical forest; ecosystem diversity exemplified by different types of tropical forest (evergreen/wet; seasonal; dry; cloud; etc.) and other ecoregion types; include ecoregional geography.
Demonstrate TWFE species diversity.
Distinguish key taxa and identify phylogenetic relations (kingdom through class).
Relate form and function to biological classification and ecology of plants and animals.

Lecture 11
Why are there so many species?
Describe ecosystem structure, including trophic levels and energy flow.
Define niche and the different categories thereof (e.g., auto- vs. heterotroph; producers vs. consumers) including fundamental and realized niches, and competition and results thereof; relate back to form and function for each group.
Illustrate macrostructure of TWFE (canopy strata; special symbiotic forms).
Describe energy flow and trophic pyramids; emphasize magnitude of insolation.
Define species richness and diversity and measurement thereof – see **Recitation 6.**
What are the hypotheses for the origin of tropical diversity?

Recitation 6
Measuring community richness and diversity.

Working with community richness measures is somewhat less mathematically complex than working with community evenness measures of diversity. The former is more practical to do, however, since it only requires knowledge of species presence or absence, and lots of databases are available for such data; this is also what most people are thinking of with regards to (species) diversity, and comparisons thereof. Evenness measures require knowledge of proportional abundances of each species and so appropriate databases are not necessarily that easy to find.

Two sources including such data for certain groups of vertebrates are:

McDade, LA; KS Bawa; HA Hespenheide; and, GS Hartshorn. 1994. La Selva: Ecology and Natural History of a Neotropical Rain Forest. Chicago: Univ. Chicago Press, 486 + x pp.

Stotz, DF; JW Fitzpatrick; TA Parker, III; and, DK Moskovits. 1996. Neotropical Birds: Ecology and Conservation. Chicago: Univ. Chicago Press, 478+ xx pp.

Lecture 12
Metabolic variation in TWFE
Describe photosynthesis with regards to summary reaction and a basic description of the component processes, including raw materials and products; include variation in carbon fixation.
Describe cellular respiration with regards to summary reaction and a basic description of the component processes, including raw materials and products; include variation in anaerobic processes.

Recognize different processes for matter and energy in ecosystems, including the second law of thermodynamics as it relates to ecosystem structure and function.
Explain why nutrients cycle in ecosytems.
Describe the basic nutrient cycles for carbon, nitrogen and water; include sources and sinks, as well as human alterations thereof; consider tropical soil structure and nutrients.
Explain gross and net primary productivity, and biomass; explain global patterns of NPP and potential limits to productivity.
Distinguish endothermy and ectothermy, and discuss their relationships to respiration and secondary productivity.

Lecture 13
Biotic Interactions I
Describe predator – prey relationships within the context of food chains and food webs. Why are food webs more common?
For four categories of prey responses to predators, appearance; structure; chemical; and, behavioral, discuss the range of prey responses to predation.
Chemical ecology – how chemistry helps in communication and defense
Describe and illustrate the various types of symbioses; how might mutualisms be considered especially important in tropical ecosytems?

Recitation #7
Develop a list of species that exhibit different patterns of distribution worldwide. Discuss differences in distribution (biogeography; fragmentation of habitat; etc.)
Develop a model: how do you see the world in 50 years? Provided with certain assumptions, students extrapolate to estimate the amounts of cropland, forest, urban areas, and species and biodiversity distributions in 50 years. These results are provided to the lecturer to demonstrate in lecture 15 how the same set of starting parameters can lead to widely differing views of the future of the planet.

Lecture 14
Biotic Interactions II
What is social behavior, and what are its advantages and disadvantages?
Illustrate the significance of social behaviors to TWFE community structure and function.
Describe variability in foraging behavior and indicate its relationship to TWFE diversity; how do predators overcome the defenses of prey?
Identify patterns of mating systems and parental care; how are these elaborated in TWFE?

Lecture 15
How do we save the TWFE?
Identify and explain the connection between tropical agriculture and conservation of TWFE; consider highways, forest clearing and immigration, as well as additional effects of (tropical) deforestation; compare large-scale with swidden agriculture.
Consider general problem of ecosystem conversion and biodiversity loss.
Climate change and its impact on TWFE.

Recitation #8:
Ecoregions

World Wildlife had a major role in developing the hotspot concept (along with Conservation International and The Nature Conservancy), and they co-sponsored big books titled "Hotspots" (a term for concentrated ecological regions of unusually high biodiversity) and "Megadiversity" (a term for countries with unusually high biodiversity). CI still features the term on their web site, but WWF and TNC have switched to the term ecoregion, which is arguably better rooted in data-based science.
Each student or group will pick a specific ecoregion, and will have to discuss the justification for investment in preserving biodiversity in that area of the world.

Lecture 16
Lecturer reviews results of recitation activity on modeling the world in 50 years (perhaps focusing on the most extreme results only)
Dilemmas in conservation biology: trade-offs in conservation vs human population pressures
What are the basic principles of population biology, and how do these relate to conservation biology?
How does TWFE illustrate the various kinds of values of biodiversity?
Consider specific examples of species or communities of conservation concern.
What are the techniques available to conservation biologists to use in conserving TWFE biodiversity?

Module 4: Biology and the human experience

The course will conclude with an examination of current literature on human evolution, including studies from different disciplines to demonstrate how our understanding of the topic is supported through integration rather than relying on a single disciplinary approach. Students will integrate their study of biology with the human experience.

Lecture 17
Human genetics
Imagine the year 2012: your entire genetic sequence is known.
2007: What do we know about human genetics and how do we know it?
Modern humans are tremendously diverse
Studies of human mitochondrial DNA; Y chromosome
Isolated populations: Icelandic study; Amish
Drug resistance; different responses to drugs
Limited number of haplotypes
Comparative genomics – information beyond Homo sapiens
Ethics: rights to human data

Recitation 9
Construct a study to determine the genetic basis of selected topics (for example, language acquisition, skin color, metabolic diseases, etc.). Discuss in class the regulations on human research and valid avenues of scientific inquiry.

Lecture 18
Biology and human history
<u>1492 and earlier: What happened? Early colonization and migration</u>
How the Americas were colonized
Relationship between biology and history
    Guns, Germs and Steel approach
Using languages to trace human migration... relationship with human genetics and archaeological studies
"The Columbian exchange" diseases, agriculture
How does human migration impact ecology and vice versa?
Collapse of civilizations

<u>Earlier still – human origins</u>
Domestication of crops and animals
Climate change – glaciation
Why were Neandertals unsuccessful?
Human evolution: Type II diabetes as example
(Which genes are "more rapidly" evolving?)
Recent articles on hominid evolution

Why biologists have come to certain conclusions about human origins
How has comparative genomics been used to address origin of humans and human migration?

Lecture 19
The bounds of biology
Misconceptions, over-simplifications and outright myths in the popular press

Recitation 10
Discuss the strengths and weaknesses of Jared Diamond's arguments.
How do biologists study these questions?

One-page paper to be turned in at the time of the final exam:
If mathematics and physics gave us computers and space travel in the 20th century, what is biology going to give us in the 21st century, and how do you see your role, as a biologist, in implementing these changes?

Recitation:
Correlate genetic divergence with morphological divergence