Subcommittee A has reviewed the proposed revisions to the Biology Major. After a thorough discussion of the proposal, the subcommittee indicated that it was disposed to recommend it to the Council for approval. However, it requested the following preliminary clarifications from Dean Caroline Breitenberger:

1. Is Biology 320 (the sophomore colloquium-style seminar) sequenced with the introductory sequence (Biology 401 and 402)?

Dean Breitenberger's response: While 320 was assigned a lower number to encourage students to take it earlier than 401–402, it is not mandatory that they do so. The program is planning to propose decimalized versions of 320 tied to specific specializations in the major; the fact that 320 is outside the required sequence will give majors flexibility to take the version of 320 that is in their area of interest at the time it is offered, rather than forcing them all into the same version of the course before they can take 401–402.

Dean Breitenberger stressed that, given that the one version of 320 has been approved, the redesigned major can be implemented without waiting for the decimalized versions, which will be a future refinement. The program plans to issue a call for proposals for versions of 320 to all the associated faculty.

2. Was the rationale for 320 to recruit new students or to build on a core? If the latter, should it be numbered higher?

Dean Breitenberger's response: the rationale is not so much recruitment as retention. In the sophomore year, students are mostly taking courses in other sciences (e.g., Chemistry); thus 320 will keep them steadily thinking about biological questions during this time. In addition, the course will help students refine their goals; some students, after taking it, may discover that their main interest lies in one of the other 7 majors in Biological Sciences (e.g., Microbiology, Zoology).

On the rationale for not having the course at a higher level, see #1. 300 is an appropriate level for a second-year course.

3. What is the approval status of 320?

Dean Breitenberger's response: the course has passed successfully through the college and ASC review process. (The decimalized versions will be submitted for review when ready.) If CAA approves the major revision proposal, 320 will get its final approval as one component in the package.

4. On p. 5 of the proposal, it is noted that "Electives within the major are also chosen from all of the courses taught by the departments in the college and from several other courses offered by units such as the College of Medicine and Public Health, the College of Human Ecology, the College of Social and Behavioral Sciences, and the College of Mathematical and Physical Sciences." Do all these units support the proposal, i.e., are concurrences needed?

Dean Breitenberger's response: it did not seem necessary to ask for concurrences in the present instance because the courses offered by the other units are included in the existing major, with the concurrence of those units. Given that the status of those courses will not change in the new major, the existing concurrences will presumably still be valid.

5. On p. 14–15 of the proposal, we recommend that Part C include an explicit statement that electives are required beyond the 15 or more credit hours in specialization areas to bring the total number of credit hours to a minimum of 45.

Dean Breitenberger's response: she agreed to make the requested addition.

Upon the receipt of Dean Breitenberger's responses, Subcommittee A voted unanimously (with one member unavailable) to recommend approval of the revised major to the Council.

Date: June 6, 2007
Subject: Proposed Revisions to the Biology Major
From: Jay Hobgood (Subcommittee C Chair)

Subcommittee C considered the proposed revisions to the Biology major on May 22, 2007. After a discussion of the key aspects of the proposed revisions, the Subcommittee voted unanimously to approved the revised major.

The principal revisions to the major are:

1. To replace the current *Core Requirements*, which currently consist of *choose one course from each five groups (Molecular, Genetic, Cellular, Organismal, Ecology/Evolution)* with *three courses taken for 10 hours of credit.* The three courses in the revised *Core Requirements* would be *Biological Sciences 320* (Sophomore Colloquium: Biological Inquiry), *Biological Sciences 401* (Integrated Biology I), and *Biological Sciences 402* (Integrated Biology II). The rationale for these changes is to *present biology as a single, integrated body of knowledge.* The current major could be viewed as a series of compartmentalized topics that are not necessarily closely linked with each other. The current approach requires that certain basic topics be taught in each group, because students may take the courses in any order. The integrated approach clearly links aspects of biology together and has the added advantage of reducing duplication of material in multiple courses.

2. To replace the current *Electives within the Major*, which consists of *at least three additional courses at the 300 level or above from one biological science department* with a *Specialization Area totaling at least 15 hours.* Student choose the specialization area in consultation with their advisors. Each specialization area will consist of a series of courses or course options that have been approved by the College of Biological Sciences Curriculum Committee. The rationale for this proposed change is *to encourage and guide students toward a cohesive, complete, and rigorous major.*

These changes *do not change the number of credit hours required to complete the major.*

If approved, the revised Biology Major would consist of:

Part A. Required Prerequisites or Supplements to the Major. (These do not count toward the 45 hours required for the major.)

Courses	**Credit Hours**
Biology 113 or H115, 114 or H116	10
Mathematic 148, 150, 151, 152 or 161 (or Honors versions)	5-19
Chemistry 121 or H201, 122 or H202, 123 or H203	15
Chemistry 251, 252, 254 or 245, 255 or 246 (or Honors versions)	10-12
Physics 111 or 131, 112 or 132, 113 or 133 (or Honors versions)	15

Part B. Core Requirements. (10 credit hours)

Biological Sciences 401 – Integrated Biology I	5
Biological Sciences 402 – Integrated Biology II	5
Sophomore Colloquium: Biological Sciences 320 – Biological Inquiry	2

Part C. Specialization Areas (Individually designed areas of further study totaling at least 15 hours)

Part D. General Requirements for the Biology Major

1. 45 or more credit hours beyond the prerequisites for the major
2. Three courses in the major must have a laboratory or data analysis component.
3. Independent Study can be included to a maximum of 5 hours and may be counted toward the laboratory/data analysis component.
4. A minimum of C- in each course in the major.
5. An overall GPA of at least 2.0 in the major.
6. Courses in the major must be approved by a Biology adviser.

The principal foci for questions and discussion during the Subcommittee's meeting were:

1. How do the revised *Core Requirements* reduce the duplication of material in multiple courses?

2. Will the courses in the revised *Core Requirements* serve as prerequisites for the courses in the *Specialization Areas*?

3. Will there be sufficient sections of the courses in the revised *Core Requirements* to meet the anticipated demand?

4. What are the procedures for the approval of additional *Specialization Areas*? There are currently only three (Life Sciences Education, Forensic Biology, and Pre-Health Professions).

Note: The Subcommittee was very favorably impressed by the plan for the assessment of the learning outcomes for students completing the major.

Changes in the October, 2007 Revisions to the Biology Major document, compared with April, 2007 document are indicated in bold type face below.

Text in 042007 document:	**Changed to in 102007 document:**
p. 1 (List of Appendices), and p. 37	
BioSci or **BiolSci** 320	→ **Biology** 320 (inconsistency in course designation)

p. 3 (Last sentence, last paragraph of Rationale):
that **would not** eliminate … → that **would** eliminate …

p. 5 (Under Relationship to Other Programs):
new **Biological Sciences** courses … → new **Biology** courses…

p. 5 (First line under Administration):
major **is currently** housed … → major **was** housed …

p. 14 (Appendix 3):

Part B Core Requirements. (**10** credit hours) →	(**12** credit hours)
Biological Sciences 401 and 402	→ **Biology** 401 and 402
401 and 402 credit hours **4**	→ 401 and 402 credit hours **5**
Biological Sciences 320	→ **Biology** 320

p. 46 (Appendix 7):
No changes are needed in the 4-year sample curriculum because the increase in credit hours in Biology 401 and 402 does not change the total hours in the major, still 45 credits.

A Proposal to Revise the Biology Major

College of Biological Sciences

Original proposal: November 2, 2005

Approved by College of Biological Sciences Curriculum Committee, pending approval of Integrated Biology courses: April 3, 2006
Integrated Biology courses (Biology 401 and 402) approved by College of Biological Sciences Curriculum Committee: April 19, 2007

Appendices

1. Current biology major program
2. Student enrollments in the College of Biological Sciences
3. The proposed biology major
4. New course requests for Biology 401 and 402
5. Proposed Biology 320 syllabus
6. Approved specialization areas
7. 4-Year sample curriculum for the new major

Name of the Major: Biology

Degrees: Bachelor of Science in Biology, Bachelor of Arts in Biology

Target Implementation Date: New freshmen declaring their interest in the biology major in Autumn 2008 will be subject to the revised major requirements. Existing students are eligible to choose to graduate under the current biology major requirements or the requirements of the revised major.

Administrative Unit: Center for Life Sciences Education, College of Biological Sciences

Rationale

Over the past quarter century, biology has experienced dramatic change. Because of the introduction of new technologies, such as relatively inexpensive computers, site-directed mutagenesis, and the polymerase chain reaction, we can examine biology from molecules to communities in far greater detail and volume than ever before. At Ohio State and around the world, monikers like "bioinformatics," "mathematical biosciences," and "biological engineering" indicate the increasingly interdisciplinary nature of biology, building on the older affiliations inherent in biophysics, geology, chemistry, and anthropology. The very nature of performing biological research has changed dramatically, often requiring more interdisciplinary collaboration and broader experience and expertise on the part of investigators, and the use to which that research can be applied has shattered boundaries of possibility and ethics. As a result, the National Research Council, in "BIO 2010: Transforming Undergraduate Education for Future Research Biologists" (2003, National Academies Press, Washington, DC), recommended a reevaluation of what we teach future biomedical researchers, and, most importantly, how we teach them. While all this has been occurring, the curricular structure of the biology major at Ohio State has changed little (though the courses themselves have changed dramatically to incorporate new information). On February 16, 2005, Dean Joan Herbers convened a committee of faculty, staff, and students, and charged that committee to examine the current biology major thoroughly and to determine whether and how the biology major should be restructured. The 2005 committee was chaired by Prof. Dave Stetson, EEOB and Honors Biology advisor, and its members were: Caroline Breitenberger, Associate Dean; Joe Conroy, graduate student, EEOB; Charles Daniels, Microbiology; Margaret Strow, Biology Advisor; Desh Pal Verma, Molecular Genetics; John Wenzel, Entomology.

The biology major at Ohio State is unusual in that it is not housed in a single department, but is a college-wide major, overseen by the College Curriculum Committee and currently administered by staff within the college office. The core

curriculum comprises courses from all of the six departments within the college (Appendix 1). Therefore, it is a broad-based, comprehensive, and demanding major.

The current biology major serves a large and diverse body of students. It is the largest of the eight majors in the college; indeed, as of autumn quarter, 2004, it is the largest single major in the university. In winter quarter 2005, 1266 of the college's 2446 majors were biology majors (Appendix 2), and 13.5% of the students enrolled in the biology major were under-represented minorities (compared with 11.4% for the college as a whole, and 12.2% for all of the Colleges of the Arts and Sciences).

A large proportion of the students who complete the biology major go to professional school, not just in medicine, but also in business, law, dentistry, optometry, pharmacy, and other disciplines. Other students go to graduate school in biological sciences or education. Students are well prepared to follow a number of career paths because the biology major is flexible and can be tailored to the individual student's needs and aspirations. Its flexibility also allows students to schedule their curriculum quite flexibly and conveniently, permitting them to complete their degree in a timely manner.

To evaluate the biology major, the review committee undertook a review of course syllabi and student curricula, and solicited feedback from faculty, advising staff and current biology majors. The curricular review indicated duplication of some material across the biology major core curriculum, as well as inadequate integration of prerequisites and fundamental biological concepts in major courses. Faculty feedback indicated that students across the college often seemed unprepared for upper-level courses, despite having taken the stated prerequisites. Faculty also expressed concern about the lack of structure in the biology major core courses. Since these courses can be taken in any order, the faculty teaching those courses are obliged to assume that the students in the course they are teaching have not had any of the other core courses, and deliver the course content accordingly. Advisor feedback indicated that students often selected elective courses and the specialization within the biology major based on expediency, especially convenience in scheduling, rather than disciplinary depth or integrity. Students generally agreed with the faculty and advisor feedback regarding the major. Interestingly, students provided numerous examples of duplication of concepts and topics in different core courses (such as cellular division, Mendelian genetics, the lac operon, or mitochondrial respiration), and urged the committee to develop a core curriculum that would eliminate this redundancy.

The Revised Biology Major

To build upon the strengths of the current biology major while ameliorating its shortcomings, the committee designed the proposed major (Appendix 3) to emphasize that biology is a single, broad, and complex body of knowledge. We believe that presenting the discipline in this way will enable students to understand more clearly the integrated, relational nature of each facet of the discipline. The biology major review committee proposed three significant changes in the structure of the biology major curriculum:

- a novel introductory sequence of courses (Biology 401 and 402, Appendix 4) to replace the current core of the biology major. We expect that these courses will support student achievement of biology major learning outcomes and that they will promote retention in the biology major. Furthermore, we expect that these courses will support student integration of the physical science and mathematics prerequisites with the biological sciences as well as help students see the real world application of biological concepts.
- a sophomore colloquium-style seminar (Biology 320, Appendix 5). The seminar is designed to encourage students to learn to participate more fully in the process of discovery and to synthesize their learning more completely.
- to encourage and guide students toward a cohesive, complete, and rigorous major, we developed the Specialization Areas (Appendix 6). These sets of courses allow individual students to focus their upper-level courses on an area of their choosing, while emphasizing the interdisciplinary nature of biology.

After the College of Biological Sciences Curriculum Committee approved the concept of the biology major revisions, they recommended that a second committee be appointed to flesh out the details of the integrated sequence of courses. This second committee was convened in autumn, 2006. The core course committee was chaired by Prof. Charles Daniels, Microbiology, and its members were: Caroline Breitenberger, Associate Dean; Erich Grotewold, Plant Cellular and Molecular Biology; Norm Johnson, Entomology; Eric Juterbock, EEOB, Lima campus; W. Mitch Masters, EEOB; Judith Ridgway, Assistant Director of the Center for Life Sciences Education; and Mark Seeger, Molecular Genetics.

The revisions proposed here for the biology major are in line with the recommendations of the NRC "BIO 2010: Transforming Undergraduate Education for Future Research Biologists" report. Specifically, the BIO 2010 report included recommendations that universities reexamine their curricula with an eye toward preparing students for an area that is increasingly interdisciplinary; that concepts from math and the physical sciences be included in biology courses; that cross-departmental teaching collaborations be encouraged; and that students have access to seminar-style courses that

communicate the excitement of biological research.

Relationship to Other Programs

The proposed major will directly replace the existing biology major, one of eight majors offered by the College of Biological Sciences. The other seven majors are: biochemistry, entomology, evolution and ecology, microbiology, molecular genetics, plant cellular and molecular biology, and zoology. The current biology major depends on the course offerings of the departments within the College of Biological Sciences. The core of the major consists of five courses chosen from an assortment of courses offered by all six departments in the college. The new 400 sequence proposed for the new major will replace this core and will slightly reduce enrollments in the courses designated by the current core. The teaching staff that will offer the new Biology courses (320, 401, 402) will be drawn from the staff within the college, thus any reduction in the teaching loads for the departments created by reduced enrollments in the current core courses will be absorbed by the requirements of the new major. Electives within the major are also chosen from all of the courses taught by the departments in the college and from several other courses offered by units such as the College of Medicine and Public Health, the College of Human Ecology, the College of Social and Behavioral Sciences, and the College of Mathematical and Physical Sciences. The electives for the proposed major will be chosen from the current array of courses and will be enlarged by allowing and designating courses from additional colleges. These electives will comprise what we call the "Specialization Area" in the new major.

Student Enrollment

At present (Sp07), approximately 1400 of the college's 2800 undergraduates are biology majors. If this proposed major is successful, we expect that that number may grow somewhat by attracting students to Ohio State who might otherwise enroll at other universities. We expect that attraction to the new biology major will be based on the strength and relevance of the new 400-level courses and the clear path to the degree defined by the specializations within the major. We also expect that retention of students in the biology major will be improved through the increased attention to their coursework on the part of the college, the increased interaction with faculty specifically interested in the biology major, and the focus on student-directed learning. Finally, it is also reasonable to expect that the integrated biology core courses will help students define their interest in the biological sciences, and may encourage many biology majors to transition into one of the other majors in the College of Biological Sciences. We view the integrated biology core courses as being a gateway, not only to the biology major, but also to the other majors in the college.

Administration

The biology major was housed in the college office, under the oversight of the Dean, an Associate Dean, and the College Curriculum Committee. A modified administrative structure has been implemented in the College of Biological Sciences to facilitate collaboration of faculty across the college in life sciences education and to implement the review committee's proposals. The new Center for Life Sciences Education (Caroline Breitenberger, Director) brings together in one administrative unit the existing Introductory Biology Program, the assessment and scholarship of teaching and learning expertise in the college, and the biology major advising group. The biology major will be housed in this new unit, and the College of Biological Sciences Curriculum Committee (with its college-wide representation) will remain the curriculum committee responsible for the biology major. The College Curriculum Committee will approve any and all changes to the curriculum, including new and altered specializations.

Advising

The advising of majors will continue as it is now. Two professional advisors in the College office (Peggy Strow and David Wells) are the primary contacts for students; these staff advisors will be housed in the Center for Life Sciences Education, and will report to the Director of the CLSE or her designee. Honors students will be advised by one of three designated faculty members; currently, those three faculty are Neil Baker (Microbiology), David Stetson (EEOB), and Tom Wilson (Entomology).

The Core Curriculum

As the committee began the discussion to revise the biology major, we reached consensus very quickly concerning the principal goal of any revision: to present biology as a single, integrated body of knowledge. The current major tends to present biology as a series of compartmented topics because of the five categories of courses within the core (biochemistry, genetics, cellular biology, organismal biology, and evolution and ecology; Appendix 1) and because of the rather discrete partitioning of the knowledge among the six departments in the college. We have developed the core 400-level courses as a two-quarter sequence that covers the broad range of biology in a single unit, and incorporates concepts from mathematics, chemistry, and other relevant scientific disciplines as appropriate. The new course requests and syllabi for Biology 401 and 402 are presented in Appendix 4. (We do not recommend that the core include a laboratory component for three reasons: First, the laboratories in the required 100-level Biology courses are being revised and updated and should provide an adequate general exposure to the breadth of laboratory techniques used in biological research. Second, the sophomore seminar, Biology 320, exposes biology majors to the methods of biological inquiry as related by active research scientists. Third, there is a requirement for three laboratory or data analysis

courses within the specialization area and electives in the major, thus providing students with hands-on experience with more advanced techniques.)

A staff member will coordinate the Biology 401 and 402 courses (Appendix 4). Two or three faculty members drawn from various departments and with complementary expertise will participate with the coordinator as a team in teaching each of the courses. We do not intend that the instructors simply deliver their assigned lectures, but that they participate in the planning of the curriculum for the complete sequence and that they remain connected with the students and faculty throughout the progress of the course. Several members of the core course development committee have agreed to be largely responsible for teaching the Wi08 and Sp08 offerings of Biology 401 and 402.

A new course designed to address the GTA training needs of the 401 and 402 courses has been proposed by Dr. Judy Ridgway. The course has been vetted by the core course design committee, approved by the College of Biological Sciences Curriculum Committee, and approved for the Graduate Interdisciplinary Specialization in College Teaching by FTAD. A Graduate Teaching Fellow has been appointed who will work during Su07 and Au07 to develop learning activities for the 401 and 402 students, and will serve as head GTA for the first offerings of Biology 401 and 402.

As far as we know, no one is offering this kind of sequence in the life sciences at Ohio State or at any other university of comparable size. (There are institutions that offer courses entitled "Integrated Biology," but in the cases we have examined, the topics are not truly integrated in the way we envision.) The lack of such courses can present a problem for students transferring to Ohio State; there may be no equivalent core to accept in transfer and it will not be possible to give students credit for any individual component of this sequence because of its unitary structure. Each transferring student will be expected to complete the entire sequence to gain the full benefit of the offering. It is likely that any intermediate or advanced courses that a transferring student brings with him/her can be included in the major specializations.

The proposed core also includes a required second-year seminar. We believe students must be encouraged to become involved in discussion and be presented with original research early in the process because these experiences are so fundamental to the process of learning and creating information in biology. We propose the creation of a new course, Biology 320 (Appendix 5), to accomplish this, but we also encourage other departments within the college to create similar courses if they do not already have such courses, and to allow biology majors to take those departmental sophomore seminars. (Biochemistry and Molecular Genetics already offer such courses.)

Specialization Area

In consultation with his or her advisor, each student should decide on an area of specialization within the broader field of biology. Each specialization area will consist of a series of courses or course options that have been approved by the College Curriculum Committee. Some possible specialization areas are listed below, and three detailed examples (approved by the College of Biological Sciences Curriculum Committee) are provided in Appendix 6. If these do not meet a student's needs, he/she may work with College of Biological Sciences faculty and advisors to choose a series of at least three advanced courses (300 and above, excluding 591 and 597) in the biological sciences with a coherent theme, and present a proposed specialization to the College of Biological Sciences Curriculum Committee for approval.

Possible Specializations for the Biology Major (details to be planned and approved by the College of Biological Sciences Curriculum Committee):
Aquatic Biology
Biophysics
Computational Biology
Education in Life Sciences
Forensic Biology
Molecular and Cellular Ecology
Molecular and Cellular Evolution
Organismal Biology
Pre-health Professions
Psychobiology
Quantitative Biology
Systematics

Bachelor of Arts Degree

Currently, the BA in Biology follows the BS program, except for Math 152, which is not required. Very few biology majors currently pursue the BA degree. This distinction will be retained in the new major; i.e. the BA in Biology has the same curricular requirements as the BS, save for Math 152, which is not required.

Assessment Plan

Dr. Judith S. Ridgway, Assistant Director Center for Life Science Education, has a degree from the College of Biological Sciences and extensive experience in science education reform and outcomes assessment. She will oversee the assessment efforts for the biology major. The assessment of this program will include a suite of outcome monitoring methods to develop a rich understanding of the impact of the program components. The assessment of the program will follow principles of good practice because this program has been

planned around values that support deep and complex student understanding of the biological sciences, the assessments will be multidimensional and ongoing, and data-driven decision making will be used to refine the program leading to the graduation of biology majors who are better prepared for graduate studies and to make contributions to society. We have in place or will soon implement most of the assessment methods described below, so we will be able to compare students in the revised major with students currently in our major programs.

We will track the students who complete the Biology 401 and 402 sequence, as an indicator of the influence that the sequence has had. We are interested in their retention in the biology major, retention in the College of Biological Sciences, and time to graduation.

The Major Field Test for Biology (http://www.ets.org/Media/Tests/MFT/pdf/ContBio2.pdf) will be administered as the final exam for Biology 402 in the first two complete cycles of the Integrated Biology Core, and student scores and subscores compared to national norms as well as to the scores of biology majors from an earlier cohort (before the implementation of the Integrated Biology Core). The Biology Major Field Test data will allow the faculty teaching the Integrated Biology Core to make quick adjustments in the course content if student understanding is shown to be deficient in specific areas. We will measure enhanced student learning and achievement by asking biology students to self-report on their learning and achievement both after they complete the sequence and upon their graduation. We will also monitor the biology major scores on the Medical College Admission Test (MCAT) and the Graduate Record Examination (GRE) biology subject test. The results of these tests will be used to compare cohorts of biology majors before and after the implementation of the integrated biology major. Taken together, these test score data will give the curriculum developers an indication of the impact of the integrated biology program on graduates' successful admission to graduate school in biological fields (GRE) and medical school (MCAT), and their learning of core concepts and biological principles.

We will develop a portfolio that will guide future implementation of the courses and assessment leading to continuous improvement. The course portfolio will be developed following the template provided by Bernstein, Burnett, Goodburn, and Savory (2006). Fellow faculty in the College of Biological Sciences and biological sciences faculty at peer institutions will complete the portfolio evaluation.

Another component of our assessment plan is to support the adoption of student-centered pedagogies that encourage integration of biological concepts by faculty, staff and GTAs. Since the activities regarding this goal are the faculty

and staff training and the GTA training, we will measure our success by counting the number of participants, gathering participant self-assessment of their preparedness and use of student-centered pedagogies, and performing document analysis to identify the use of those pedagogies.

Students who take any of several upper level biological science courses write analyses of biological research as part of their course requirements. Samples of student papers will be collected from several of these courses and analyzed by a panel of faculty using a simple rubric based on the student outcomes for biology and writing. The faculty panel will receive training on the use of the rubric prior to the actual analysis of student papers. The goal of this analysis is to directly measure student levels of understanding and abilities as they complete the integrated biology major curriculum, and one prominent feature of the rubric will be the emphasis on integration of biological concepts.

To ensure continuous improvement of the program, an assessment report will be distributed to the CLSE Director and the College of Biological Sciences Curriculum Committee on an annual basis. Additional or different methods will be added to the assessment suite as special needs emerge during the evolution of the revised major.

Appendix 1: Current biology major program

The biology major provides a structured program that includes the major areas of importance to modern biology, as well as an in-depth concentration of study in one of the six departments in the College of Biological Sciences.

Part A. Required Prerequisites or Supplements to the Major (Do not count toward the 45 hour major)

- Biology 113 or H115, 114 or H116
- Mathematics 148, 150, 151, 152 or 161
- Chemistry 121 or H201, 122 or H202, 123 or H203
- Chemistry 251, 252, 254 or 245, 255 or 246
- Physics 111 or 131, 112 or 132, 113 or 133

Part B. Core Requirements

Choose one course from each of the five groups below.

1. Molecular (choose one):
   - Biochemistry 511, or 613 and 614
2. Genetic (choose one):
   - Microbiology 581
   - Molecular Genetics 500, or 605 and 606
3. Cellular (choose one):
   - EEOB 415 or 630
   - Microbiology 509, or 520 and 521
   - Molecular Genetics 602 or 607
   - Plant Biology 648
4. Organismal (choose one):
   - EEOB 410, or 405.01 and 405.02
   - Entomology 500 or 611F
   - Microbiology 661
   - Plant Biology 436, or 630 and 631
5. Ecology/ Evolution (choose one):
   - EEOB 370 or 400 or 413.01 or 413.03
   - Entomology H444 or 641
   - Microbiology 664 or 665
   - Molecular Genetics 640

Part C. Electives within the Major

- At least three additional courses at the 300 level or above from one biological science department.
- At least two of the three courses must be lecture-based courses
- When courses are taken as a sequence to satisfy a Core requirement (part B), all but one of the courses in the sequence may also be used to satisfy the three additional courses requirement.

- Independent study is strongly recommended (693 or H783), with up to five credit hours counting towards the 45 hour major.

Requirements - Parts B and C together

- A minimum grade of "C-" in each course and a 2.0 overall GPA in the major.
- At least three courses must have a laboratory.
- Total: 45 or more hours at the 300 level or above.
- COURSES IN THE MAJOR MUST BE APPROVED BY YOUR BIOLOGY ADVISER.

Appendix 2: Student enrollments in the College of Biological Sciences

Winter quarter enrollments

	Biochem	Biology	Entomol	Evol & Ecol	Microbiol	Mol Genetics	Plant CMB*	Zoology	BIO Headcount**
2002	149	993	7	25	149	227	11	285	2004
2003	150	1067	10	45	156	251	10	291	2121
2004	188	1171	14	37	175	285	13	306	2317
2005	196	1266	13	34	219	264	15	310	2446
2006	202	1378	26	40	249	249	9	319	2646

Winter quarter Honors enrollments

	Biochem	Biology	Entomol	Evol & Ecol	Microbiol	Mol Genetics	Plant CMB*	Zoology	BIO Headcount**
2002	58	280	1	9	41	91	1	54	579
2003	65	274	0	21	43	120	0	68	620
2004	78	319	3	13	44	124	2	66	649
2005	73	329	3	13	57	120	2	52	651

* Formerly Plant Biology
** Includes BIO-Undecided students; students with double majors within the College are counted just once in the headcount

Appendix 3 -- revised 2-6-2008: The proposed biology major

Biology Major Program

The biology major provides a survey of the essential areas of study in modern biology, an individually-tailored focus of study, and an emphasis on methods of communication in the discipline.

Part A. Required Prerequisites or Supplements to the Major. (Do not count toward the 45 hour major)

Courses	**Credit Hours**
Biology 113 or H115, 114 or H116	10
Mathematics 148, 150, 151, 152 or 161 (or Honors versions)	5-19
Chemistry 121 or H201, 122 or H202, 123 or H203	15
Chemistry 251, 252, 254 or 245, 255 or 246 (or Honors versions)	10-12
Physics 111 or 131, 112 or 132, 113 or 133 (or Honors versions)	15

Part B. Core Requirements. (12 credit hours)

Biology 401 – Integrated Biology I	5
Biology 402 – Integrated Biology II	5
Sophomore Colloquium: Biology 320 – Biological Inquiry	2

Part C. Specialization Areas (Individually-designed areas of further study totaling at least 15 hours; **some specializations may require more than 15 credit hours. Note that most students will need additional electives to complete the 45 credit hour major – see Part D.)**

In consultation with his or her advisor, each student must decide on an area of specialization within the broader field of biology. Certain series of courses have already been approved for specialization and are listed below. If these do not meet a student's needs, he or she may work with College of Biological Sciences faculty and advisors to choose a series of at least three advanced courses (300 and above, not including 591 and 597) in the biological sciences with a coherent theme, and present the proposed specialization to the College of Biological Sciences Curriculum Committee for approval.

<u>Specialization Areas for the Biology Major</u>
Aquatic Biology
Biophysics
Computational Biology
Education in Life Sciences
Forensic Biology
Molecular and Cellular Ecology
Molecular and Cellular Evolution

Organismal Biology
Pre-health Professions
Psychobiology
Quantitative Biology
Systematics

[This list of specializations includes topics that are not included in Appendix 6, "Specialization Areas." Those listed in Appendix 6 represent the pattern that we expect to see. The additional areas listed above are being developed for approval by the College of Biological Sciences Curriculum Committee. We anticipate that an increasingly broad range of specializations will become available over time.]

Part D. General Requirements for the Biology Major

- 45 or more credit hours beyond the prerequisites to the major (some students may need additional courses at the 300-level or above after completing the Core **[Part B]** and Specialization Area **[Part C]**)
- Three courses in the major must have a laboratory or data analysis component
- Independent Study, e.g. Biol 699 or H783, can be included to a maximum of 5 hours, and may be counted towards the laboratory/data analysis component
- A minimum of C- in each course in the major
- An overall GPA of at least 2.0 in the major
- Courses in the major must be approved by a biology advisor

Electives in the biology major – College of Biological Sciences
Any course at the 300 level above in the College of Biological Sciences, not including 591 and 597.

Up to 5 credit hours of independent study or undergraduate research (693, H783, or 699) in the College of Biological Sciences.

Electives in the biology major – other Colleges at the Ohio State University
Up to 10 credit hours of courses in units outside the College of Biological Sciences may be counted on the biology major, upon approval by a biology advisor. Examples of courses that are regularly approved include:

Up to 5 credit hours of independent study or undergraduate research (693, H783, or 699) in an approved area of the life sciences.

Anatomy 200: Introductory Anatomy

Animal Science 310: Principles of Animal Systems Physiology
Animal Sciences 610: Physiology of Reproduction

Anthropology 300: Human Origins
Anthropology 302: Modern Human Physical Variation
Anthropology 409: Primate Evolution
Anthropology 411: Human Ecological Adaptations
Anthropology 610: Ethnobotany

Environment and Natural Resources 618: Ecological Engineering and Science
Environment and Natural Resources 725: Wetland Ecology and Management

Human Nutrition 310: Fundamentals of Human Nutrition

Molecular Virology, Immunology, and Medical Genetics 600: Evolution of Emerging Viruses

Neuroscience 300: Introduction to Neuroscience

Pharmacology 600: General Pharmacology

Physiology and Cell Biology 311 and 312: Principles of Human Physiology I and II
Physiology and Cell Biology 601 and 602: Organ System Physiology I and II

Plant Pathology 401: General Plant Pathology
Plant Pathology 600: Introduction to Bacterial and Viral Pathogens of Plants

Psychology 313: Behavioral Neuroscience
Psychology 513: Introduction to Cognitive Neuroscience

Appendix 4: Biology 401 and 402

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)
401 Integrated Biology I

Number Title
IntegratdBiologyI U 5
18-Character Title Abbreviation Level Credit Hours

Summer Autumn Winter x Spring 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: Wi, Au 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): Biology 113 and 114 or HS AP Biology; 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? _402__

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.

1. Provide the rationale for proposing this course:
Revisions to the biology major

2. Please list Majors/Minors affected by the creation of this new course. Attach revisions of all affected programs. This course is (check one): x Required on major(s)/minor(s) ☐A choice on major(s)/minors(s)
☐ An elective within major(s)/minor(s) ☐ A general elective:

3. Indicate the nature of the program adjustments, new funding, and/or withdrawals that make possible the implementation of this new course.

4. Is the approval of this request contingent upon the approval of other course requests or curricular requests?

Yes x No ☐ List: Biology 402

5. If this course is part of a sequence, list the number of the other course(s) in the sequence: 402

6. Expected section size: 250 (lecture), 25 (rec) Proposed number of sections per year: 2

7. Do you want prerequisites enforced electronically (see OAA manual for what can be enforced)? Yes x No ☐

8. This course has been discussed with and has the concurrence of the following academic units needing this course or with academic units having directly related interests (*List units and attach letters and/or forms*):
Not Applicable ☐
Departments in the College of Biological Sciences: Biochemistry, Entomology, EEO Biology, Microbiology,
Molecular Genetics, Plant Cellular and Molecular Biology

9. **Attach a course syllabus that includes a topical outline of the course, student learning outcomes and/or course objectives, off-campus field experience, methods of evaluation, and other items as stated in the OAA curriculum manual and e-mail to asccurrofc@osu.edu.**

Approval Process The signatures on the lines in ALL CAPS (e.g. ACADEMIC UNIT) are required.

1.	Academic Unit Undergraduate Studies Committee Chair	Printed Name	Date
2.	Academic Unit Graduate Studies Committee Chair	Printed Name	Date
3.	ACADEMIC UNIT CHAIR/DIRECTOR	Caroline Breitenberger **Printed Name**	**Date**

After the Academic Unit Chair/Director signs the request, forward the form to the ASC Curriculum Office, 105 Brown Hall, 190 West 17th Ave. or fax it to 688-5678. Attach the syllabus and any supporting documentation in an e-mail to asccurrofc@osu.edu. The ASC Curriculum Office will forward the request to the appropriate committee.

5.	**COLLEGE CURRICULUM COMMITTEE**	David Horn **Printed Name**	**Date**
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 401: Integrated Biology I U 5 credit hours

Winter quarter, 2008

Course description: Biology 401 is the first 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 first 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 113 and 114, or AP Biology in high school; 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 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, and coordinates student assessment activities.
Contact information:
Office hours:

Course objectives: Students will apply and explore in greater depth facts and concepts introduced in introductory biology courses. They will begin 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.

Readings: 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 an appropriate reference work.

Grading:

Recitation activities and on-line assignments 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. Many of these assignments will involve answering questions that will be similar to questions on the midterm and final examinations.

Midterm or in-class quizzes 20 points

Paper 10 points

Write a 2-page summary article, as if for the science pages of the New York Times, describing the topic presented by the guest lecturer (lecture 17 in the syllabus). Your paper should summarize the experimental methods and results, including an analysis of variables that were considered (or not) and limits in interpretation of the data presented.

Attendance and participation 10 points

Attendance will be taken during recitation, and in lecture. Participation will be evaluated based on participation in the recitation activities. 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:

Lecture 1 Introduction to Biology 401/402

- General description of case studies approach
- Review all of introductory biology
- Use of the reference book and other course materials
- Progression across the two courses (increasing depth, complexity, emphasis on integration)

Student milestones in achieving fluency in the language of biology

- Research lecture in Biology 401; research seminar of student's choice in Biology 402
- Read literature for general scientific audience in Biology 401; read research literature in the discipline in Biology 402

Expectations in these courses:

The student:

- Will participate in classroom and recitation discussions and activities
- Will visit the course web site on a regular basis to find out the background material that must be reviewed before class and to complete the on-line activities
- Will review material in reference textbook as needed before class
- Will attend lecture
- Will be an active learner
- Will progress from (a) simply understanding background material to (b) understanding how many different biological disciplines are integrated by researchers in the field to (c) being able to succinctly explain to others how several different areas of the biological sciences are relevant to contemporary issues in the biological sciences

Faculty:

- Will engage students in active learning
- Will model the integration of biological principles across different disciplines with their underlying physical and mathematical concepts

GTAs:

- Will engage students in active learning
- Will model the integration of biological principles across different disciplines with their underlying physical and mathematical concepts

Use of the reference book and other course materials

Module 1: The nature and origin(s) of life

This module is designed to reinforce the importance of the study of physics, chemistry and mathematics in the expansion of the student's knowledge of the biological sciences. Mathematical concepts are reinforced with examples of time, size and probability. The physical sciences are integrated throughout the descriptions of living organisms and their environments.

Lecture 2

What is science; scientific inquiry
- Alternative hypotheses
- How do we define life?

The fundamental interconnectedness among mathematics, physical sciences, and biology
- Earth science and what we know or surmise about early life
- Early evolution
  - Fossil evidence
  - The RNA world hypothesis

Recitation 1

Define "environment" in a biological context
- How do living organisms obtain energy from the environment?

On-line activity: energy flows and/or the thermodynamics of life

Lecture 3

Continue to examine interconnectedness among mathematics, physics, chemistry and biology
- Time:
  - Age of the earth
  - Age of *Homo sapiens*
    - How many generations?
- Size and number of organisms:
  - Significance

Module 2: Life in extreme environments

This module is designed to reinforce fundamental biological themes having to do with the cell and its contents by introducing students to organisms growing in novel environments.

Lecture 4

Single-celled organisms
- Classification

Extreme environments
- Example: deep-sea thermal vents
- What are the environments that support life
- Cell structure and how it is maintained in extreme environments

Recitation 2 Metabolism – general review of universal aspects

On-line activity: simulation of a living organism (build a cell)

Lecture 5
Universality of metabolism
Anaerobic pathways

Lecture 6
Genomes and evolution
Central dogma (DNA to RNA to protein)
Genomic information

Recitation 3
Molecular evolution
Definition
Methods for study
On-line activity: simulation of evolution

Lecture 7
Adaptation
Adaptation at the organismal level
How do organisms change in response to their environment
How do organisms change their environment
Adaptation at the genomic level
Evolutionary clues in genes
Effect of mutation and gene flow on evolution
Humans as another example of an extreme environment

Lecture 8
The evolution of organismal classification systems
Systematics
Woese

Recitation 4 Review for midterm
On-line activity: develop a map of the topics and concepts integrated in Module 2

Lecture 9 **Midterm exam**

Module 3: Malaria

Malaria is chosen as the system to be studied in this module because understanding host-vector-parasite interactions and disease control can integrate fundamental biological concepts from molecules to ecosystems. The material in this module is presented at a higher level of complexity than the previous modules.

Lecture 10
Epidemiology of a human disease: malaria as a model

Recitation 5

Dynamics of host-pathogen interactions
Co-evolution
    On-line activity: Mortality vs morbidity

Lecture 11
The pathogen and its vector

Lecture 12
The human immune system
Control of disease: Vaccine development

Recitation 6
The immune system
    On-line activity: Recombination of IgG genes – how many different molecules?

Lecture 13
Molecular aspects of the disease
    How does the parasite evade its host?
        Erythrocyte structure
        Hemoglobin structure and function

Lecture 14
Selection based on disease resistance
Sickle cell anemia and other thalassemias
Human ecology: selection and human evolution

Recitation 7
Other examples of human disease as evolutionary selective pressure
    On-line activity: Think like a pathogen

Lecture 15
Mosquito control
Vector ecology
Ecological approaches to disease control
Ecological implications of disease control

Lecture 16
Treatments for malaria
    Most existing treatments come from plant sources
    Why do plants make these compounds?
The search for drugs – chemistry, mathematics
Types of drugs, their mechanism of action
Drug testing and approval
Ethics

Recitation 8

Background materials for guest lecture
Discuss scientific paper(s) that represent topic to be covered by guest lecturer

Lecture 17 Guest lecturer will present his or her research on a topic relevant to modules 1-3, at a level appropriate for students in this course.

Module 4: Sex and death

This module introduces topics that encourage the student to understand the complexity of living organisms, and to think of them as more than assemblages of single cells.

Lecture 18
Evolution relies on genomic diversity
- How is genetic diversity created and maintained?
- Why engage in sex?
- Consequences of in-breeding

Recitation 9
Meiosis
- Exchange of genetic material
- Why is it important?

On-line activity: access and report on data about life-span studies

Lecture 19
Death
- Evolutionary benefits of death
- What life-span means; what determines life-span
- Extension of life span: role of diet, oxidative stress
- Apoptosis

Lecture 20 Selection and domestication
- Genetic engineering
- Ethics and social issues

Recitation 10 Review for final exam

Final exam: Students will be provided, at least one week in advance of the final exam, with a set of essay questions which require an integrated approach to biology. Students will be directed toward resources to develop complete answers to the essay questions, and then will have to answer 1-2 of these questions in class for the final exam.

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.

1. Provide the rationale for proposing this course:
Revisions to the biology major

2. Please list Majors/Minors affected by the creation of this new course. Attach revisions of all affected programs. This course is (check one): x Required on major(s)/minor(s) ☐A choice on major(s)/minors(s)
☐ An elective within major(s)/minor(s) ☐ A general elective:

3. Indicate the nature of the program adjustments, new funding, and/or withdrawals that make possible the implementation of this new course.

4. Is the approval of this request contingent upon the approval of other course requests or curricular requests?

Yes x No ☐ List: Biology 401

5. If this course is part of a sequence, list the number of the other course(s) in the sequence: 401

6. Expected section size: 250 (lecture), 25 (rec) Proposed number of sections per year: 2

7. Do you want prerequisites enforced electronically (see OAA manual for what can be enforced)? Yes x No ☐

8. This course has been discussed with and has the concurrence of the following academic units needing this course or with academic units having directly related interests (*List units and attach letters and/or forms*):
Not Applicable ☐
Departments in the College of Biological Sciences: Biochemistry, Entomology, EEO Biology, Microbiology,
Molecular Genetics, Plant Cellular and Molecular Biology

9. **Attach a course syllabus that includes a topical outline of the course, student learning outcomes and/or course objectives, off-campus field experience, methods of evaluation, and other items as stated in the OAA curriculum manual and e-mail to asccurrofc@osu.edu.**

Approval Process The signatures on the lines in ALL CAPS (e.g. ACADEMIC UNIT) are required.

1. Academic Unit Undergraduate Studies Committee Chair — Printed Name — Date

2. Academic Unit Graduate Studies Committee Chair — Printed Name — Date

3. ACADEMIC UNIT CHAIR/DIRECTOR — Caroline Breitenberger — **Printed Name** — **Date**

After the Academic Unit Chair/Director signs the request, forward the form to the ASC Curriculum Office, 105 Brown Hall, 190 West 17th Ave. or fax it to 688-5678. Attach the syllabus and any supporting documentation in an e-mail to asccurrofc@osu.edu. The ASC Curriculum Office will forward the request to the appropriate committee.

5. **COLLEGE CURRICULUM COMMITTEE**	David Horn **Printed Name**	**Date**
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
1492 and earlier: What happened? Early colonization and migration
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

Earlier still – human origins
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

Appendix 5: Proposed Biology 320 syllabus

Biology 320
Biological Inquiry

Objectives: A seminar-style class designed to introduce sophomores majoring in biology to methods of inquiry in the biological sciences, to foster faculty-student interactions, to develop appropriate professional behavior, to develop life-long learning skills in the sciences, and to stimulate critical thinking skills.

Course structure: Class meets once per week for 1h 48 min. Students receive 2 credit hours. Class offered Au, Wi, Sp quarters, with different coordinators and speakers each quarter. Maximum enrollment: 100 students each quarter. Class is graded S/U.

Prerequisites: Biology 114 and Rank 2 status (student has earned at least 45 credit hours); restricted to students with a major in the College of Biological Sciences; not open to students with credit for Biochem H200 or MolGen H220, or other similar departmental freshman or sophomore seminars to be developed; or by permission of the Course Coordinator.

Course coordinator: The Course Coordinator is a faculty member in the College of Biological Sciences. Each offering of Biology 320 will be widely publicized to student lists, College of Biological Sciences advisors, and Arts and Sciences advisors at least one quarter in advance. The Coordinator is responsible for inviting and scheduling seminar speakers, preparing and distributing handouts and limited background materials describing the next week's seminar (typically 3-5 pages), working with discussion leaders to make sure class discussion is appropriate, evaluating each discussion group, and collecting and grading reflection papers each week. All College faculty are expected to participate in Biology 320 (as speakers and/or coordinators).

Grading policy:
Attendance and class participation: 30 points
Journal: 30 points
Discussion leader group activity: 40 points
There is no final exam for this class.
≥ 75 points = Satisfactory
< 75 points = Unsatisfactory

Attendance and class participation: For each absence, no matter what the excuse, the student will receive a 5 point penalty. Under certain circumstances (e.g. serious and unexpected health problems, family emergency), the Course Coordinator may choose to give a student a special assignment to make up points missed due to class absences (*e.g.* attend a different seminar and prepare

a written report). Participation points will be awarded based on each student's interaction with the seminar speakers, *i.e.* whether they occasionally ask questions and participate in class discussions – quality of the interaction is more important than quantity.

Journals will be collected at the end of the quarter, and may also be collected and reviewed during any class period by the course coordinator. The journal entries have three parts: questions based on the background reading, answers to those questions, and reflections on the significance of the seminar. Each week, students should bring to class their journal, in which they have written at least one question based on their reading of the background material. Questions may include topics such as the significance of the research; the research methods; interpretation of results; how this research relates to specific findings by others; ethics of the research; *etc.* Before the next class period, each student should briefly answer their own questions, whether or not they were addressed during the seminar or the post-seminar discussions. In addition, students should comment on how the seminar has affected their understanding of the topic addressed.

Discussion leader group: A group of 10-12 students each week will be assigned to introduce the speaker and lead the discussion at the end of the seminar.

Responsibilities of the group include:

- Seek out additional background readings and materials (including Internet, textbook, and peer-reviewed publications)
- Post significant readings on the course website, accompanied by a 1-2 sentence synopsis of each posted reading written by one of the group members
- Each individual group member should send the Course Coordinator 2-3 questions for discussion by 4:00 pm 2 days before the seminar [The Course Coordinator will compile and edit the questions, possibly adding a few, and distribute the compiled list to the entire group the day before the seminar]
- Assign responsibilities within the group, such as introducing the speaker, leading the discussion, and thanking the speaker
- Introduce the speaker at the beginning of class (introductions should include the speaker's name, educational background, current position, and seminar title -- some creativity is acceptable, but speakers should be treated with respect and courtesy)
- At the end of the seminar, ask for questions from the class, seed the discussion by asking questions for the Coordinator-approved list, and steer the class discussion in appropriate directions
- Conclude the classroom discussion and thank the speaker (again, some creativity is acceptable, but speakers should be treated with respect and courtesy)

- Meet with the Course Coordinator to discuss their performance and to document the group's activities for the Course Coordinator

Discussion leader group participants will receive up to 20 points as a "group" grade and up to 20 points as an individual score. It is expected that, at a minimum, each student in the group will have asked one question during the discussion and will have summarized one significant paper for the website.

Sample class schedule:

Week 1 (Speaker: Course Coordinator):

Course expectations and mechanics
Traditions and expectations in biological inquiry
How do scientists choose a research topic?
How is research supported?
What is a peer-reviewed publication?
Research databases
Explain theme for the quarter; background information
Distribute background reading for Week 2 seminar speaker
Assign discussion leader groups for weeks 2-10

Weeks 2-10:

3:00 Start of class – Discussion leaders introduce speaker
3:10 Seminar speaker and title TBA
4:00 Speaker concludes - Discussion leaders ask questions and lead discussion -- each discussion leader should ask at least one question; discussion leaders should also watch for questions from the audience; seminar speaker may be involved in discussion, or may stand back and let students engage each other in discussion
4:35 Speaker summarizes student discussion, adding his/her own perspective and knowledge to the discussion
4:40 Discussion concludes – Discussion leaders thank speaker
Course Coordinator hands out materials for next week's speaker and provides a brief transition to the next speaker's topic
4:45 Class dismissed

Course Coordinator meets 5-10 min with group discussion leaders to review their performance

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. Signing attendance sheets and/or turning in assignments for students not in attendance are also examples of

academic misconduct. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/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 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/.

Appendix 6: Approved Specialization Areas

Specialization Areas for the Biology Major

Note that courses may be approved in the Specialization Areas below which would not otherwise be approved for the Biology major. Students are responsible for checking course prerequisites; not all are included in the lists below. Where several courses are listed with an "or," only one of those listed may be counted toward the Biology major. When two courses are linked with an "and," both must be taken to satisfy the requirement within the specialization.

Life Sciences Education (≥ 31 credit hours beyond the core)
Students wishing to pursue a career as a high school science teacher are encouraged to complete a bachelor's degree in the content area (e.g., biology) and apply to the Master's of Education (M.Ed.) program through Ohio State's College of Education. For additional information about entrance requirements to the M.Ed. program, please refer to www.coe.ohio-state.edu.

Required: Introduction to Biological Chemistry, Biochemistry 511 (5 cr.)
Required: General Genetics, Mol Gen 500 (5 cr.)
Required: Evolution, EEOB 400 (5 cr.)
Required: Basic and Practical Microbiology, Micro 509 (5 cr.)
Required: General Plant Biology, PCMB 300 (5 cr.)
Additional Coursework: Choose at least two courses from the following list or consult with a Biology major advisor for additional options.

- General Entomology, Entomology 500 (5 cr.)
- Introduction to Ornithology, EEOB 322 (5 cr.)
- Diversity and Systematics of Organisms, EEOB 405.01 (4 cr.) (*strongly recommended*)
- Ichthyology, EEOB 621 (5 cr.)
- Mammalogy, EEOB 625 (5 cr.)
- DNA Fingerpinting Workshops in Columbus Public Schools, Mol Gen, Biochem, or Micro 591 (2 cr.; may be counted only once)

Forensic Biology (≥ 20 credit hours beyond the core)
Recommended additional prerequisite: Introduction to Physical Anthropology, Anthropology 200 (5 cr.)

Required: an introductory course or sequence in biochemistry, Biochemistry 511 or Biochemistry 613 and 614 (5-8 cr.)
Required: an introductory course or sequence in molecular genetics, Mol Gen 500 or Mol Gen 605 and 606 (5-8 cr.)
Additional coursework in molecular biology and forensic science: choose at least three courses or series from the following list:

- Biological Anthropology of the Human Skeleton, Anthropology 603.01, 603.02, 603.03, or 603.04 (5 cr.)
- Forensic Anthropology, Anthropology 640.04 (5 cr., Anthro 603.01 prereq.)
- Third course in Biochemistry and Molecular Biology, Biochemistry 615 (4 cr.)
- Eukaryotic Molecular Genetics Laboratory, Mol Gen 601 (5 cr.)
- Cell Biology, Mol Gen 607 (3 cr.)
- Molecular Genetics, DNA Transactions, Mol Gen 701 (3 cr.)
- A course or sequence in microbiology, Micro 509 or Micro 520 and 521 (5-10 cr.)
- DNA Fingerpinting Workshops in Columbus Public Schools, Mol Gen, Biochem, or Micro 591 (2 cr.; may be counted only once)

Pre-Health Professions (≥ 23 credit hours beyond the core)
Required: an introductory course or sequence in molecular genetics, Mol Gen 500 or Mol Gen 605 and 606 (5-8 cr.)
Additional coursework: choose at least four courses from the following list:

- A course or sequence in biochemistry, Biochemistry 511 or Biochemistry 613 and 614 (5-8 cr.)
- Evolution, EEOB 400 or H400 (5 cr.)
- A course or sequence in microbiology, Micro 509 or Micro 520 and 521 (5-10 cr.)
- Principles of Animal Cellular and Developmental Biology, EEOB 415 or H415 (4 cr.)
- Vertebrate Histology, EEOB 630 (5 cr.)
- A course in human or comparative anatomy, Anatomy 200 or EEOB 410 or H410 (4-5 cr.)
- A sequence in human physiology, Physiology CB 311 and 312 or Physiology CB 601 and 602 (10 cr.)

Appendix 7: 4-Year Sample Curriculum

FRESHMAN YEAR: 51 credit hours

Autumn:	Biological Sciences 100
	Chemistry 121
	Mathematics 150
	GEC-Social Science
Winter:	Biology 113
	Chemistry 122
	Mathematics 151
Spring:	Biology 114
	Chemistry 123
	Mathematics 152
	GEC-English 110

SOPHOMORE YEAR: 45 credit hours

Autumn:	Biology 320 (Major course)
	Chemistry 251
	GEC-Foreign Language
	GEC-Arts & Humanities
Winter:	Biology 401 (Major course)
	Chemistry 252
	Chemistry 254 or 245
	GEC-Foreign Language
Spring:	Biology 402 (Major course)
	Chemistry 255 or 246
	GEC-Foreign Language
	Elective

JUNIOR YEAR: 45 credit hours

Autumn:	Major Course
	Physics 111 or 131
	GEC-Foreign Language
Winter:	Major Course
	Physics 112 or 132
	GEC-Social Science
Spring:	Major Course
	Physics 113 or 133
	GEC-Second Writing Course

SENIOR YEAR: 40 credit hours

Autumn:	Major Courses
	GEC-History
Winter:	Major Courses
	GEC-History
	Elective
Spring:	Major Course
	GEC-Arts & Humanities

(Distribution of credit hours: 60 credit hours GEC excluding natural science and mathematics; 67 credit hours natural science and mathematics prerequisites; 45 credit hours on the major; 9 credit hours of electives = 181 credit hours)