

**DEGREE/PROGRAM CHANGE  
FORM C**

**Fields marked with \* are required**

**Name of Initiator:** Nathan Holscher **Email:\*** [holscher@unm.edu](mailto:holscher@unm.edu) **Date:\*** 11-02-11

**Phone Number:\***

Initiator's Rank / Title\*

Program Manager

Faculty Contact\* Felisa A. Smith

Administrative Contact\*

Nathan R. Holscher

Department\* Biology

**Division** Arts and Sciences

**Program** Interdisciplinary Biological and Biomedical Sciences

**Branch** Main

**Proposed effective term:**

Semester

Fall ▼

Year

2012 ▼

**Course Information**

Select Appropriate Program

Graduate Degree Program ▼

CIP Code

Name of New or Existing Program

\* PhD Minor- Integrated Biology

Catalog Page Number

Select Category

Minor ▼

Degree Type

Ph.D.

Select Action

New ▼

**Exact Title and Requirements as they should appear in the catalog.**

See current catalog for format within the respective college (enter text below or upload a doc/pdf file)

Please see attached document.

[Title and Requirements Oct 2011.doc](#)

☐ **This Change affects other departmental program/branch campuses**

Reason(s) for Request \* (enter text below or upload a doc/pdf file)

Please see attached document.

[Rationale Oct 2011.doc](#)

Statements to address budgetary and Faculty Load Implications and Long-range planning

\* (enter text below or upload a doc/pdf file)

Please see attached document.

[Budgetary Faculty Load and LR Planning Oct 2011.doc](#)

## **Exact Title and Requirements as They Should Appear in the Catalog**

### **Ph.D. Minor in Integrated Biology**

Awarded to students who satisfactorily complete 3 core classes offered by the Program in Interdisciplinary Biological and Biomedical Sciences. These are: Bio 520 (3 credits; also offered as ANTH 620, CS 520, ECE 620, STAT 520), Bio 503 (3 credits; also offered as ANTH 560, CS 591C, STAT 579, MATH 579, ), and Bio 524 (3 credits; also offered as ANTH 624, CS 524, ECE 524, STAT 524). In addition, students must satisfactorily complete a Post Doctoral Preparatory Course (1 credit; currently offered as Bio 502), and a scientific ethics course/seminar taught or approved by PiBBs, along with two additional integrated courses in biology, or for biology students, two additional integrated courses outside of biology to demonstrate depth in a secondary discipline. Finally, students must establish an interdisciplinary doctoral dissertation committee, which should have co-mentorship or active participation by faculty from two or more different departments, including biology. A total of 16 credit hours are required for the award of a transcribed minor at the PhD level.

## **Rationale/ Reason for Request**

The greatest scientific challenges for the 21<sup>st</sup> Century are inherently interdisciplinary. Research to address these challenges in biology requires the input of new ideas, methodologies, and investigative strategies from multiple disciplines, including the physical sciences, engineering, mathematics, and the social sciences. Yet, very few students are encouraged to think boldly and broadly, or are trained to go beyond existing disciplinary frameworks. We aim to prepare Ph.D. students for sustained careers doing cutting edge interdisciplinary research by: i) developing a common baseline of mathematical, computational and biological knowledge and skills, ii) exposing trainees to the disparate ways that various scientific disciplines tackle and solve scientific problems, and iii) helping them acquire the communication, scientific and social skills necessary to work effectively in small interdisciplinary research teams.

The *Program in Interdisciplinary Biological and Biomedical Science* (PiBBs; <http://pibbs.unm.edu/>) unites faculty and students from 6 departments (Biology, Computer Science, Electrical and Computer Engineering, Mathematics and Statistics, Physics and Astronomy and Anthropology), 2 colleges (College of Arts and Science and the College of Engineering at UNM) and 3 prestigious institutions (University of New Mexico, Santa Fe Institute and Los Alamos National Laboratory) with research interests in biological theory, modeling and bioinformatics into a comprehensive program leading to a Ph.D. concentration in *Integrative Biology*. A standing crop of 8+ trainees (some supported by UNM) receive several years of support to engage in didactic and hands-on training in the conduct of interdisciplinary research. A common facility, visiting scholars and a series of other professional and social activities help foster and maintain a vibrant and exciting community of interdisciplinary scholars.

The *Program in Interdisciplinary Biology and Biomedical Science* developed from earlier antecedents and has been formally recognized by the university since 2006. Over the past decade, we have a well-established track record in training highly successful Ph.D. students in interdisciplinary biological science using the research team approach. Our graduate training program has been supported by a NSF Graduate Research Traineeship, a NSF Biocomplexity grant and most recently, a grant from the HHMI-NIBIB Interfaces Initiative for Interdisciplinary Graduate Training. These graduate training programs were developed within the broader context of interdisciplinary faculty research and postdoctoral scholarship supported by numerous grants from Federal agencies, the Packard Foundation's Interdisciplinary Science Program, and the Burroughs Wellcome Fund. These activities have resulted in extensive interaction and collaboration, not only among multiple departments within the University of New Mexico (UNM) but also among UNM, the Santa Fe Institute (SFI), and Los Alamos National Laboratory (LANL). The education and research programs have always been closely integrated. Indeed, graduate students have initiated and led some of the most novel and interdisciplinary research. Since neither SFI nor LANL is a degree-granting institution, close ties with UNM have allowed all three institutions to benefit greatly from graduate student participation in cutting-edge interdisciplinary research. By offering training opportunities to graduate students that are cross and interdisciplinary, PiBBs aims to produce scientists that think broadly, deeply and creatively across traditional disciplines.

There are two major components to the PiBBs curriculum. The first is a series of 5 specialized courses that include a repertoire of pedagogical strategies all with proven effectiveness in interdisciplinary training. We aim to develop the skills and language necessary to conduct interdisciplinary biological science. These include a fall topics course (TiBBs), a spring seminar course (SiBBs), a course in developing and teaching topical interdisciplinary biology courses (CiT), a course in professional development and a scientific ethics course; these are described in more detail below. The second major component involves the establishment of an interdisciplinary Ph.D. committee, with members drawn from 2 or more departments, and a sequence of 2 or more additional advanced electives in a department outside of the student's primary affiliation. This requirement is meant to demonstrate that the student has developed both breadth and depth in an area outside their main affiliation; these courses will vary to ensure that each student has a rigorous diversified curriculum related to student interest and research direction.

The core curriculum consists of courses common to all students in the program. These courses have been developed with the specific aim of 1) developing a common baseline of mathematical, computational and biological knowledge and skills necessary for successful interdisciplinary collaborations; 2) exposing students to the disparate ways in which various scientific disciplines tackle and solve scientific problems; 3) exposing students to the language, culture, technology, literature and different perspectives/approaches used by various disciplines; and 4) learning the communication, scientific and social skills necessary to work effectively in small interdisciplinary research teams. The timeline for the training program can be seen in Table 1.

Note that students will receive disciplinary Ph.D.'s in their affiliated departments. Because we complement rather than compete with departments, they and their colleges have become enthusiastic supporters of PiBBs. In the process, we have been able to negotiate a reduction in the coursework and other formal degree requirements of each department, so that students have time to devote to the coursework and research training required by our program. The overall goal of our curriculum is to allow students broad latitude in defining their individual area of biological interest, while at the same time providing oversight and guidance to ensure that they receive rigorous and thorough interdisciplinary training that includes learning the language and approaches used by various scientific disciplines. A Ph.D. minor in Integrative Biology would be a formal recognition of completion of this highly interdisciplinary curriculum.

The success of our training program can be judged by the accomplishments of the trainees. To date, they have received many prestigious awards (including a NIH Director's Pioneer Award, four NSF Postdoctoral Fellowships, and multiple awards from professional societies), given scores of oral and poster presentations at scientific meetings, and published more than 150 papers. The journals include *Science*, *Nature*, *PNAS*, *PLoS*, and *Proceedings of the Royal Society* as well as more specialized ones. Recent trainees have been extremely successful in obtaining postdoctoral and/or faculty positions at academic and research institutions, including SFI, Harvard, Princeton, Brown, Pennsylvania, Rockefeller, MIT, Arizona (2), Florida, Wisconsin, UC Santa Barbara, UC San Diego, Georgia, Illinois, Indiana, North Carolina,

Kansas, Utah State (2), St. Louis U, New Mexico, Old Dominion, Carleton, College of Santa Fe, British Columbia, Cambridge, Basel, U Costa Rica, Instituto Tecnológico Autónomo de México, Maquarrie, National Center for Ecological Analysis and Synthesis (5), Erasmus Medical Center in Rotterdam, Scripps Institution of Oceanography, Monterey Bay Marine Institute, Fred Hutchinson Cancer Institute, and the Institute for the Study of Atmosphere and Ocean (U Washington).

**Detailed description of core PiBBs courses (already approved and in catalog):**

- Bio 520-TiBBs (*Topics in Integrative Biological and Biomedical Science*): This is an integrated course that bridges scientific disciplines and demonstrates the utility and power of collaborative research. The course employs active learning pedagogies, in particular collaborative and cooperative problem-based learning. It consists of 3 topics or units, each team-taught by different combinations of faculty from different disciplines/departments. For each unit, students from different departments are grouped into “teams” and assigned a problem. Teams present their solutions at the end of each unit. Topics of units change annually so as to present a variety of cutting-edge research areas and to introduce new faculty. Because content varies each semester, it can be repeated for credit. (Fall, 3 credits)
- Bio 503-SiBBs (*Seminar in Integrative Biological and Biomedical Science*): This course deliberately exposes students to multiple possible role models. It is centered around seminar presentations and in-depth discussions with invited speakers, some from UNM, SFI, and LANL, but most from other institutions. Students are expected to take a leadership role in nominating, hosting, and interacting with visiting scientists. This course addresses the cognitive and social aspects of learning where students expand their intellectual horizons by interacting intensively with visiting and resident faculty and their fellow students. Because content varies each semester, it can be repeated for credit. (Spring, 3 credits)
- Bio 524-CiT (*Collaborative interdisciplinary Teaching*): This course is designed to provide advanced level Ph.D. students with a background in inquiry-based interdisciplinary biological science curriculum and pedagogy. The approach is a problem based one: two or three advanced Ph.D. students from different departments propose, develop, and teach a 400-500 level course from the ground up. The students work closely under supervision of faculty mentor(s) to develop a syllabus, define the content and scope of the course, learn teaching methodologies and do actual instruction. Teaching truly interdisciplinary classes entails special problems. Because these areas are emerging, textbooks are non-existent and devising an appropriate syllabus can be challenging. In addition, undergraduate students, drawn from a variety of educational backgrounds, have varying levels of background skills and knowledge. Thus, a major emphasis is on effective communication. Trainees develop and incorporate a variety of teaching skills that they will need to become effective faculty teachers, including inquiry strategies, investigative laboratory, data analysis, and computer experiences, and problem-based methodologies. The graduate student instructors meet weekly with the faculty mentor to go over designed educational readings, instructional technology, and assessment techniques. (Fall or Spring, 3 credits)



## **Budgetary and Faculty Load Implications and Long-range Planning**

The proposed Ph.D. minor will formalize participation by graduate students in an established and ongoing program. Our earlier training efforts were institutionalized in 2006 when the Program in Interdisciplinary Biology and Biomedical Sciences (PiBBs) was formally established with support from the Howard Hughes Medical Institute (HHMI-NIBIB Interfaces Initiative) and UNM. Importantly, because of support already in place from the University, the National Institutes of Health, and the Howard Hughes Medical Institute, the formalization of participation in our program presents no added costs to the University. The courses are already being taught, and the infrastructure is in place. For example, a seminal event in 2010 was the completion and subsequent occupation of our new PiBBs suite. This space was designed specifically for PiBBs with support from the department of Biology, the College of Arts and Sciences, and the Provost and President's offices. It contains three student offices (each housing 3-4 students), space for faculty, postdocs, sabbatical visitors, several work areas, a gathering space, and a conference/classroom space accommodating approximately 25 people. A recent National Academy of Science report highlighted the need for a "sense of place" in graduate training. The report went on to state that housing students from different departments together was crucial to help foster interdisciplinary training. The close contact and interactions allow not only a sense of program identity to develop, but also give students the opportunity to acquire communication, scientific and social skills to talk to scientists from different cultures. We can attest to the difference that our PiBBs suite has made; it has developed an identity, and students "hang out" in our common area. Moreover, the building and furnishing of our PiBBs space was a testament to the commitment UNM has already made to our program.