

## REVIEW OF THE M.S. IN BIOLOGICAL SCIENCES

Classification of Instructional Program (CIP) Code: 26.0101  
Biology/Biological Sciences, General

### OVERVIEW

The M.S. in Biological Sciences program at Illinois State University is housed in the School of Biological Sciences within the College of Arts and Sciences. The school also offers a minor in biological sciences, a B.S. in Biological Sciences, a B.S. in Biological Sciences Teacher Education, a B.S. in Molecular and Cellular Biology, and a Ph.D. in Biological Sciences. The B.S. in Biological Sciences, the M.S. in Biological Sciences, and the Ph.D. in Biological Sciences programs have been reviewed in the current program review cycle, whereas the B.S. in Biological Sciences Teacher Education program and the B.S. in Molecular and Cellular Biology program are scheduled for review in 2023-2024 and 2021-2022, respectively.

The M.S. in Biological Sciences program prepares students for advanced research positions in industry, government, healthcare organizations, and academia. The program also prepares students for doctoral education. Students may specialize in a sub-discipline of the field by selecting from among six interdisciplinary sequences or by working with faculty to design a unique plan of study related to the student's interests and career goals. Although biological sciences master's programs at many other universities are intended solely to prepare students for doctoral study, the M.S. in Biological Sciences program is designed to prepare students for whom the master's degree will be their terminal degree. From the beginning of the program, students are taught and mentored by faculty in basic and applied research, often working collaboratively in student-faculty research groups.

#### Enrollment by Sequence, Fall Census Day, 2010-2017 M.S. in Biological Sciences, Illinois State University

|   | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|------|------|------|------|------|------|------|------|
| Behavior, Ecology, Evolution, and Systematics | 9    | 9    | 12   | 11   | 12   | 12   | 11   | 10   |
| Bioenergy Sciences                            |      | 1    | 2    | 1    | 1    | 2    | 2    | 3    |
| Biomathematics                                | 3    | 2    | 2    | 1    |      | 1    | 2    |      |
| Biotechnology                                 | 13   | 9    | 10   | 9    | 12   | 12   | 12   | 11   |
| Conservation Biology                          | 5    | 4    | 1    | 2    | 2    | 1    | 3    | 6    |
| Neuroscience and Physiology*                  |      |      |      |      |      | 1    | 2    | 7    |
| No sequence/specialized plan of study         | 10   | 6    | 6    | 8    | 11   | 9    | 8    | 2    |
|   |      |      |      |      |      |      |      |      |
| Total   | 40   | 31   | 33   | 32   | 38   | 38   | 40   | 39   |

\* Established effective 5-18-15

#### Degrees Conferred by Sequence, Graduating Fiscal Year 2010-2017\*\* M.S. in Biological Sciences, Illinois State University

|   | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|------|------|------|------|------|------|------|------|
| Behavior, Ecology, Evolution, and Systematics | 4    | 2    | 4    | 1    | 3    | 2    | 5    |      |
| Bioenergy Sciences                            |      |      | 1    |      | 1    |      |      | 1    |
| Biomathematics                                |      | 1    | 1    | 1    |      |      |      |      |
| Biotechnology                                 | 4    | 6    | 4    | 5    | 2    | 3    | 7    | 2    |
| Conservation Biology                          | 1    | 2    | 1    | 1    | 1    | 2    | 2    | 1    |
| Neuroscience and Physiology*                  |      |      |      |      |      |      | 1    |      |
| No sequence/specialized plan of study         | 3    | 3    | 1    | 2    |      | 1    | 2    | 1    |
|   |      |      |      |      |      |      |      |      |
| Total   | 12   | 14   | 12   | 10   | 7    | 8    | 17   | 5    |

\* Established effective 5-18-15

\*\* Summer, fall, and spring terms (e.g., graduating fiscal year 2017 consists of the following terms: summer 2016, fall 2016, and spring 2017)

## **EXECUTIVE SUMMARY PROGRAM REVIEW SELF-STUDY REPORT**

### **Program goals**

To provide students with opportunities ...

- To conduct publishable research in particular areas of the broad discipline of biological sciences,
- To develop their research knowledge and skills in particular areas of the broad discipline of biological sciences,
- To increase their general knowledge of biology through formal training in the laboratory, field, and classroom.

### **Student learning outcomes**

- In depth understanding of advanced concepts in biology
- Developing advanced scientific literacy
- Developing understanding of biological research

### **Curriculum** (2017-2018)

Graduation requirements: 30 credit hours of coursework in addition to a thesis

Students may choose to complete one of six sequences or a plan of study arranged with the student's major professor and thesis committee members. The six sequences are behavior, ecology, evolution, and systematics; bioenergy sciences; biomathematics; biotechnology; conservation biology; and neuroscience and physiology (established since the prior program review).

Regardless of plan of study, the focus of the program is on research. Students are permitted to write their thesis in the form of one or more research articles, which are subsequently submitted to and usually published by national or international science journals. Almost all students serve as a teaching assistant or research assistant. Teaching assistants teach and mentor undergraduate students in laboratory sections, and research assistants contribute to faculty-led research projects.

### **Program delivery**

The program is offered on the Normal campus.

The program is delivered through face-to-face instruction.

The School of Biological Sciences offers a study abroad opportunity through its Rainforest Ecology course. The course includes field work at La Selva Biological Station in Costa Rica.

### **School faculty** (Fall 2017)

26 tenure track faculty members (8 Professors, 10 Associate Professors, and 8 Assistant Professors)

4 part-time non-tenure track faculty members (1.08 FTE)

Courses in the M.S. in Biological Sciences program are taught by full-time tenured or tenure track faculty members who actively contribute to scholarship in the discipline.

All fall 2017 tenure track faculty members in the School of Biological Sciences had a doctorate and post-doctorate experience. One non-tenure track faculty member held a doctorate in biology. Four faculty members held the title of Distinguished Professor, and one held the title of University Professor. Among retirees and emeritus professors, seven held the title of Distinguished Professor. From 2012 through 2016, faculty members collectively averaged 58 publications (journal articles and book chapters) per year; seven faculty members collectively served on 13 different review panels for grants submitted nationwide to the National Institutes of Health, National Science Foundation, U.S. Department of Energy, and the Beckman Foundation; and 10 faculty members collectively served on 12 editorial boards of national or international scientific journals. In 2016 the 26 tenure track faculty members in the school published 48 research articles in refereed journals and three book chapters. Nine of the 48 articles were lead-authored by graduate students, and three articles named one or more graduate students as co-authors. Also in 2016

the 26 tenure track faculty members attracted extramural funding in excess of \$1.5 million from federal, state, or local government agencies or from private foundations. Eleven current faculty members have been recognized with a cumulative total of 33 college or university-level teaching or research awards.

### **Specialized accreditation**

The M.S. in Biological Sciences program is not accredited or certified by a national association. In the biological sciences, accreditation or certification is available only to undergraduate biological sciences teacher education programs.

### **Changes in the academic discipline, field, societal need, and program demand**

Exponential growth of scientific and technical knowledge, particularly in biology, and its ever increasing impact on all aspects of human life means there is a growing need for trained biologists capable of collaborating broadly and eager to take on many different roles. These scientists are not needed just as faculty members in academia but are also needed across all sectors of human endeavor. Both the Illinois Department of Employment Security and the U.S. Department of Labor predict that biology-related and health-related job markets will be among the strongest in the future economy. Further, there is a need for trained scientists regardless of the level of their highest postsecondary degree. Scientists having earned a master's degree in the field as their terminal degree are in demand by both for-profit and non-profit employers. In addition, lead researchers from doctoral programs in biological sciences, including the biological sciences doctoral program at Illinois State, need technical staff to make research progress. These demands indicate that master's programs producing well-trained technicians are critical for the future.

### **Response to previous program review recommendations**

In response to the 2009-2010 review of the M.S. in Biological Sciences program, faculty of the School of Biological Sciences has pursued the following initiatives.

*Maintain competitive financial support for students in the program.* The School of Biological Sciences has been able to increase the graduate assistantship stipend for its master's students only modestly over the last eight years due to the lack of budget increases. An increase in the stipend from \$1,115 per month to \$1,200 per month was only possible by reducing the number of teaching assistantships awarded by the school. The \$1,200 stipend is 64 percent of the stipend paid to doctoral students who serve as teaching assistants although all teaching assistants in the school are expected to perform the same work.

*Maintain and increase research start-up funds for newly-hired faculty members.* Many faculty members hired by the School of Biological Sciences in the late 1990s or early 2000s were granted research start-up packages ranging from \$50,000 to \$100,000 each when they joined the school. From 2000 to 2009, start-up package amounts granted by the school were substantially higher, ranging from \$250,000 to \$400,000. The additional funds were contributed by the school and the College of Arts and Sciences. Since 2009, however, the school has been unable to maintain those higher amounts because it has lacked a fund dedicated to start-up packages.

*Strengthen relations with graduates of the program.* The School of Biological Sciences has increased its communication with school graduates, including graduates of the M.S. in Biological Sciences program, through newsletters and other web-based information, interactions on social media platforms, special events, and more frequent surveys. As a result, more graduates are accessing information offered by the school and more graduates have been invited to return to campus for seminars or Homecoming events.

### **Major findings**

The M.S. in Biological Sciences program continues to succeed in graduating highly competent scientists prepared for a wide variety of positions related to the biological sciences and allied fields. The program is among the decreasing number of master's level biological sciences program nationally that are designed especially for students who seek a master's degree in the field as their terminal degree (rather than a doctorate). The demand statewide, nationally, and internationally for highly skilled graduates of master's level biological sciences programs is expected to increase in the coming years in response to technological advances in many fields. But although the M.S. in

Biological Sciences program is healthy, there are several aspects of the program in need of attention in the coming years. Among them are the ability of the program to compete with comparator and aspirational programs for the most qualified students and the ability to attract highly qualified faculty members.

### **Initiatives and plans**

- Increase the stipend to students in the M.S. in Biological Sciences program who serve as teaching assistants. Increasing the stipend is necessary for the program to compete with its comparator and aspirational programs for highly qualified students. Students granted teaching assistantships contribute significantly to the education of undergraduate students at the University, including biological sciences majors and students in other academic programs.
- Expand efforts to recruit students for the M.S. in Biological Sciences programs beyond offering teaching assistantships. Strategies to explore include offering university-sponsored fellowships for first-year students and increasing the number of research assistantships supported by externally-funded research projects.
- Continue efforts to offer nationally-competitive research start-up packages for newly-hired faculty members. It is imperative that the school hire highly qualified scientists and then support them in establishing their research program as quickly as possible, so that they can attract external funding and, in turn, highly qualified graduate students. Sources external to the school and college should contribute to the start-up packages, so school and college budgets are not adversely and severely impacted when hiring faculty members.
- Further strengthen graduate alumni relations through more frequent surveys, newsletters and other web-based information, and special events such as alumni seminars and research symposia. These activities will help the school track its alumni and gather feedback from them regarding its programs.

## **PROGRAM REVIEW OUTCOME AND RECOMMENDATIONS FROM THE ACADEMIC PLANNING COMMITTEE**

**Review Outcome.** The Academic Planning Committee, as a result of this review process, finds the M.S. in Biological Sciences program to be in Good Standing.

The committee recognizes Biological Sciences faculty for offering a rigorous master's program that is becoming increasingly rare among its comparator programs in its focus on preparing students for employment in the field in addition to doctoral study. As is appropriate to graduate education, the M.S. in Biological Sciences program is research intensive. The thesis is the one and only capstone option in the program, and students are permitted to submit their thesis in the form of one or more articles appropriate for publication in a peer-reviewed journal. Students are encouraged to present research results at school seminars and symposia, the University Research Symposium, and national and international conferences. Supporting students with their research is the Beta Lambda chapter of Phi Sigma, the national biology honors society. Beta Lambda is the largest such chapter in the country and is one of the most active with regard to its sponsorship of seminars and symposia and its granting of funds to students to support their research.

Central to the quality of the program and its reputation regionally and nationally is the quality of its faculty and students. The committee commends both. Faculty members are highly credentialed and well respected in their fields. Their contributions have been recognized through numerous college and University awards for research, teaching, or service. Four Biological Sciences faculty members hold the rank of Distinguished Professor, the highest faculty rank conferred by the University. From 2012 through 2016, 10 faculty members served on 12 journal editorial boards and seven faculty members served on 12 research grant panels, among them panels of the National Science Foundation, United States Department of Agriculture, United States Department of Energy, and European Research Council. During the same period, faculty members collectively averaged 58 peer-reviewed publications annually. Biological Sciences faculty members are prolific at obtaining external grant funds to support their research and, in turn, research involving their students. Faculty members have been awarded more than \$35 million in research grants during their tenure at Illinois State. Demand for the program among prospective students permits faculty to select the most highly credentialed applicants. For the fall 2016 term, for example, only 12 of 69 applicants were admitted. Faculty members carefully vet program applicants through campus interviews. In the case of applicants for whom travel to campus is difficult, including applicants residing in other states or countries, interviews are held via telecommunications application software with real-time audiovisual capabilities.

The committee recognizes the students in the M.S. in Biological Sciences program who serve as teaching assistants for their contributions to undergraduate education at the University. The graduate assistants teach undergraduate students in biology laboratory sections and work with students individually to help them develop their research skills. The teaching assistants also help with general education courses taken by students enrolled in other academic programs at the University. The School of Biological Sciences offers seven general education courses that annually enroll more than 3,500 students. The committee commends biological sciences faculty members for their expansion of teaching assistant orientation and training since the last program review. New teaching assistants now attend a three-day orientation held prior to the fall semester.

**Recommendations.** The Academic Planning Committee makes the following recommendations to be addressed within the next regularly scheduled review cycle. In the next program review self-study report, tentatively due October 1, 2025, the committee asks the program to describe actions taken and results achieved for each recommendation.

**Continue the dialogue about increasing graduate assistantship stipends.** Almost every student in the M.S. in Biological Sciences program serves as a graduate assistant. The graduate assistants make valuable contributions to research in the discipline and to undergraduate education at the University. The self-study report articulates concerns regarding competitiveness of the stipend paid to graduate assistants in the program relative to stipends offered by biological sciences programs at other universities. The self-study report also notes that the stipend amount paid to biological sciences students at Illinois State has remained unchanged for five years. The committee recommends that the school continue dialoguing with the college, Graduate School, and university administration regarding the need to increase assistantship stipends. The committee also suggests exploring ways to engage individual donors and external entities in contributing financially to stipends and fellowships.

**Develop a plan for maintaining and replacing high-cost equipment.** The committee concurs with faculty in its plan to work with the College of Arts and Sciences to address school equipment needs, including equipment for biology laboratories. A long-term plan for maintaining and replacing essential but high cost equipment will likely benefit the school particularly during times of fiscal austerity. Working through the college may lead to collaborative approaches with other programs and academic units, such as equipment sharing, cost sharing, or savings resulting from coordinated purchasing.

**Develop and implement a plan for furthering student diversity.** While the ratio of female students to male students in the program is approximately 1:1, less than 10 percent of students self-identify with racial or ethnic groups traditionally underrepresented in the discipline (excluding international students). The self-study report indicates that the program has not needed to recruit students given that the program receives many times the number of applicants it can admit. Given that strong demand, the lack of recruitment efforts may be a missed opportunity to increase student diversity. The committee encourages the program to develop and implement a student recruitment plan that articulates goals for diversity. The committee suggests that the program work with the Office of Enrollment Management and Academic Services and with University Advancement to identify strategies. The committee further suggests that the recruitment plan include strategies for nurturing a climate of inclusiveness.

**Develop and implement a plan for furthering faculty diversity.** The committee acknowledges the obstacles faced by the school in achieving greater gender and racial/ethnic diversity among its faculty, such as the low percentage of doctoral candidates who are women or persons of color. It is evident from the self-study report that the school is committed to working toward greater faculty diversity despite those obstacles. The committee commends the school for its efforts and encourages the school to continue them. However, it may be difficult for the school to increase faculty diversity without having goals and strategies for achieving them. Accordingly, the committee encourages the school to develop and implement a plan for furthering gender and racial/ethnic diversity among its faculty, articulating in the plan specific goals for diversity. The committee recommends that the plan also address retention efforts, setting forth strategies for nurturing an environment of inclusiveness.

**Identify and address unmet needs for timely access to research resources.** According to the self-study report, the combination of academic journal costs in the discipline rising at rates higher than inflation and Milner Library serials budgets remaining stable at best has made it increasingly difficult for biological sciences faculty and students to access the literature they need to conduct their research. This includes inquiries faculty members need to conduct to develop their own research questions and apply for external grants funds to explore them. The library has sought to maintain faculty and student access to the journals most needed by biological sciences faculty and students

through cancellations of less-used serials. In an effort to continue providing some level of access to cancelled periodicals, the library has provided article-level access in many cancelled periodicals through adoption of the *Get It Now* service where Milner pays for individual article access rather than expensive yearly subscriptions. It has also subscribed to *BrowZine* which provides table of content access to periodicals, including many that were cancelled. Despite these efforts, access to research literature remains problematic for some biological sciences faculty members. The committee is concerned about the impact this situation may have on research and teaching in the school and on the ability of the school to retain and attract highly credentialed faculty. Accordingly, the committee recommends a collaborative effort involving the School of Biological Sciences, the College of Arts and Sciences, and Milner Library to document unmet needs for timely access to research literature by biological sciences faculty and students and to identify strategies for addressing those needs. Success in doing so may require additional efforts by the library but also contributions from sources external to the library. Options that might be explored may include modifications to the student fee structure to include supplemental funding for research literature or incorporating funding for research literature in external grant requests.

**Evaluate the appropriateness and effectiveness of course scheduling and curriculum review processes.** The self-study report notes that faculty members had regularly been contributing to course scheduling and curriculum review processes in their sections until the sections were eliminated and a less organized approach to the processes evolved. The self-study report alludes to concerns regarding that change. The committee encourages discussion of course scheduling and curriculum processes currently being deployed by the school to identify any concerns faculty may have regarding their appropriateness or effectiveness.

**Develop and implement a plan for tracking alumni.** Primarily via communication between faculty members and their former students, the program has compiled contact information for 83 percent of students graduating from the program between 2009 and 2017. The school has expanded its efforts to maintain communication with its alumni through numerous venues including newsletters and social media. The committee recommends that the school build on those accomplishments by developing and implementing a plan for systematically tracking and networking with alumni. Many elements of such a plan are already in place, including the alumni database that is being populated and the communication strategies already being deployed. A plan can guide those efforts going forward by identifying what information will be collected and what contacts will be made when and by whom. Some information collected through implementation of the plan, such as alumni perceptions of the program and alumni career outcomes, could be used in the student learning outcomes assessment process (see below). In addition, alumni could be recruited to provide career advice to students, assist them with job placement, or contribute financially to the school.

**Continue refining and implementing the student learning outcomes assessment plan.** The committee recognizes the program for its use of thesis proposals and defenses to identify broad trends in student learning that can inform decisions regarding the curriculum. The committee encourages faculty to continue that practice. The following suggestions are intended for consideration by faculty when it next considers refinements to the assessment plan. The suggestions are intended to further the efficacy and sustainability of the assessment process.

Beyond assessment associated with theses, the assessment plan provides for assessment in courses and seminars. However, the plan is not specific as to the courses and seminars in which assessment is to occur and the assignments and projects in those courses and seminars that are to be assessed. The committee suggests focusing assessment efforts on the courses and assignments that can yield the most useful feedback relative student learning outcomes. The assessment plan also provides for assessing learning relative to all student learning outcomes annually. Faculty might considering staggering assessment across multiple years, which could be less taxing on faculty. Assessment methods set forth in the plan are all direct assessment methods. While direct methods are preferable in that they assess actual learning, indirect methods used to gauge perceptions of program stakeholders may also yield information that can inform program and curriculum design. For example, information gleaned from implementation of the aforementioned alumni tracking system could provide valuable insights regarding alumni satisfaction and career development. Faculty might also consider a student exit survey and queries of non-completers.