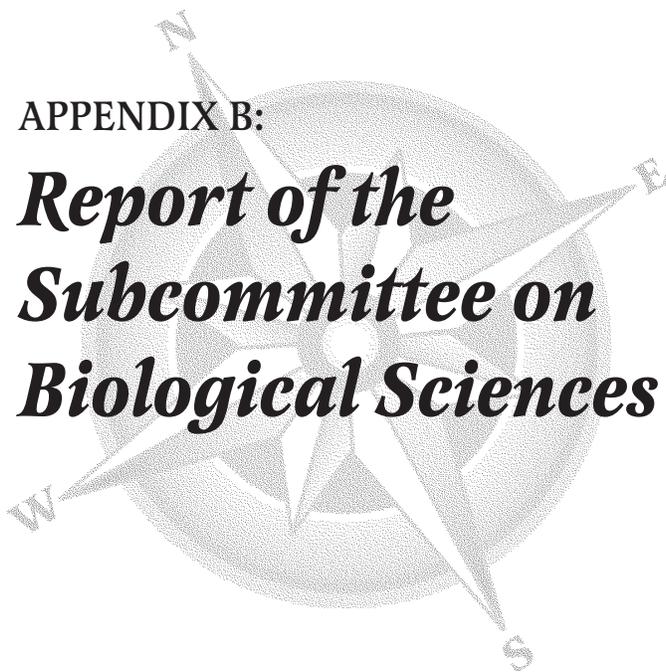


APPENDIX B:

***Report of the  
Subcommittee on  
Biological Sciences***





# *Responsible Biology*

## **Subcommittee Members**

**Jo Handelsman (Chair)**, Plant Pathology, College of Agricultural and Life Sciences

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## **Executive Summary**

The field of biology is undergoing a revolution that is bringing challenging opportunities and responsibilities for biologists at the University of Wisconsin–Madison. Scientific developments in areas as diverse as genetics and evolution have led to dramatic insights and new technologies that are changing agriculture, medicine, and our interactions with the environment. It is imperative that biologists be responsible leaders in their research and teaching, and educate people to live thoughtfully in this brave new world that is deeply affected by biological decisions.

At present, the University of Wisconsin–Madison is arguably the strongest site for biology research and education in the United States. The campus combines a tradition of high quality across the full spectrum of biological disciplines with depth in many fields. There is superb and innovative graduate and undergraduate training, a breadth of professional schools, an excellent history of collaboration among biologists and between biologists and scholars in the social and physical sciences and the humanities, a terrific and consistent record of generating funding from federal and private sources, and a history of integrating the discovery of knowledge with its application. It is rare to find such excellence in a public university with a strong ethic of serving the people of its state and the world. The UW–Madison is therefore ideally poised to be at the forefront in developing “responsible biology”—biology that includes a broad spectrum of participants engaged in the responsible construction and distribution of knowledge generated by the current revolution in biology. However, to respond effectively to the present challenges and avoid slipping into mediocrity threatened by the recent funding shortfalls, there are significant gaps that currently need to be filled, areas to be strengthened, and new directions to pursue.

## **Recommended goals**

- To stimulate innovative and interdisciplinary research and education while strengthening core disciplines.
- To enhance the quality of undergraduate education in biology by broader adoption of proven teaching approaches and more hands-on experiences.
- To train graduate students both deeply and broadly to be responsible leaders of the next generation of biologists.
- To revitalize the tradition of two-way communication with the public and their legislative representatives.

## Suggested actions to achieve these goals

- **Recruit and retain the best faculty, staff, and students.** This will require: recognition and accommodation of the diverse needs of potential students, staff, and faculty; new approaches to graduate recruiting to make the campus more comprehensible and accessible; vigorous, innovative recruiting efforts to achieve a community of biologists that more nearly reflects the gender and ethnic composition of society; increased tolerance and improved campus climate to retain those that we recruit; and promotion of the highest standards of academic and scientific conduct.
- **Secure the resources required to be a preeminent research university for the 21st century.** Increase positions for faculty and staff and renovate or replace unsafe and outdated facilities. New funding from traditional state and federal sources as well as from private donors and foundations will be required. Stimulate and support highly innovative research with an endowment, titled “The Millennium Biology Fund”, dedicated to this purpose. Set the goal of raising \$1 billion dollars by 2010.
- **Maximize the use and impact of current resources.** Obtain greater flexibility and autonomy in budget and personnel management; utilize the outstanding potential of academic staff in the creation, integration, transfer, and application of knowledge; and protect and expand the use of our unique and irreplaceable resources for teaching and research, such as the Campus Natural Areas and the Arboretum.
- **Provide support and incentives for faculty and staff to place greater effort in teaching and outreach.** These activities will be encouraged by establishing endowed professorships in teaching and outreach; providing more support staff for teaching, particularly lab courses; streamlining academic life by reducing committee work and providing better assistance for the preparation of grant proposals and other administrative activities.
- **Keep UW biology creative and vibrant by strengthening planning and implementation processes for the division.** We recommend that the three Divisional Committees of the Biological Sciences—the Strategic Planning, Curriculum Planning, and Tenure Committees—assume responsibility for monitoring implementation of and updating as appropriate the recommendations of this and future planning exercises in consultation with the BioDeans. In addition, we recommend revising the current membership criteria for the Strategic Planning and Curriculum Planning Committees to include appropriate participation of academic staff.

The details of proposals for responsible biology presented in this summary are provided in the following document.

## Responsible Biology

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### Theme of this report

The future of the Earth and its people is intimately tied to the biological sciences. The issues that challenge us include environmental degradation, global change, population pressures, food security, health policy, and the potentially revolutionary applications of modern genetics. Our ability to deal with these and other as yet unforeseen issues will require breakthroughs from cutting-edge biological research as well as a new vision that we term “responsible biology.” In this regard, as a society we will need to make

tough decisions about use and distribution of knowledge and resources. As a university, we will need to educate all citizens to participate in and understand these decisions. To do this, our students and the citizens we educate will need a knowledge of biology and its context. To attain our goals, we must be responsible with respect to equitable treatment of the people who research, teach, and learn biology to maximize the use of human resources, and we must deliver to a broad community knowledge of biology.

The hallmarks of modern biology are interaction and integration. Now, more than ever in the history of biology, the science concentrates on interactive behaviors of molecules, organisms, and populations and integrates across a broad spectrum of variables including size and level of complexity. The activities of biologists parallel these two important features of their subjects. Biologists must interact broadly with each other and with scholars in other fields and other types of institutions, and they must integrate other sciences with their own to tackle the complex questions of the biology that intrigue the modern mind. What we see in biology are two organizational constants: (1) diverse fields of study practiced across scales in time and space over which the biology of all organisms is realized, from tiny microbes to giant trees and massive mammals; and (2) a need for interactive and integrative science among otherwise specialized and isolated fields of study.

Interactions and integration operate at all levels of the natural world, from molecules to ecosystems. The science of biology must enable both the focused study of molecules, cells, or organisms and the integration of the results of that study into the biological, physical, and social universe. Examples of this dual approach abound. Current thrusts in molecular and cell biology focus on interactions between molecules that explain how cells interpret signals from the environment, providing new approaches to drug and pesticide discovery. Developmental biology integrates across genetics, molecular biology, and cell biology to discern the processes by which a cell differentiates or spawns a tissue of dedicated function, which are critical to applications as diverse as human genetic disease, organ transplant technology, and crop productivity. Ecology draws together the subdisciplines of biology to understand how organisms respond to their environments and to discern the structures of populations, communities, ecosystems, and the biosphere, providing the knowledge that underpins sound environmental policy. Extending through all of biology today is genomics, which offers insight into the organization, origin, and unity of life by describing the most basic blueprint material shared by all organisms.

As biology has grown more sophisticated, new insights have been gained concerning the extent to which interactive science must be pursued. If a university is to offer a responsible approach to biological research and teaching for the new millennium, we must make more permeable the membranes between people, departments, disciplines, and institutions. Sorting out life's complex mysteries will require that the tentacles of biology reach out to, penetrate, and draw upon physical sciences such as chemistry, physics, engineering, mathematics, computer sciences, geology, and meteorology; social sciences such as psychology, sociology, economics and anthropology; and humanist disciplines such as philosophy and ethics. Partnerships between biologists and non-biologists are essential to answering the big questions about of life processes creatively and responsibly as well as to advancing practical problem solving. Appreciation of the impacts of biology will come from engagement with a broader community including economists, sociologists, and lawyers. Moreover, the modern era of biology demands collaborations between academic biologists and the private sector as volumes of genome sequence data, robotics and high throughput screening methods, and elegant remote sensing environmental technology accumulate in industrial settings and transform the landscape of biological research.

This report embraces the value of the totality of biology at UW—research, teaching, and outreach—and recognizes that the quality of each of these activities is dependent

**Sorting out life's complex mysteries will require that the tentacles of biology reach out to, penetrate, and draw upon physical sciences such as chemistry, physics, engineering, mathematics, computer sciences, geology, and meteorology; social sciences such as psychology, sociology, economics and anthropology; and humanist disciplines such as philosophy and ethics.**

on excellence in the others. Furthermore, our status as a public research university is defined by all three. While our other activities appear to be better understood outside the university, the role of our research mission in the quality of our educational and outreach programs is not broadly appreciated by the public. This needs to be corrected. Everything we accomplish in undergraduate, graduate, and outreach biology education relies on, is influenced by, and derives credibility from the power of research in the biological sciences on the Madison campus. Indeed, it is the very linkage of education and research that is the strength of the campus. Recent erosion of the strength of research and gaps in key areas caused by that erosion have placed us in a precarious position for the future. With appropriate investment in new positions and physical infrastructure, we will continue to be one of the greatest institutions for biology in the world. The success of the recommendations in this report is dependent on actions that build a broad strength in biological research.

This report focuses on three interwoven priorities in the biological sciences: research preeminence, undergraduate education, and graduate education. Outreach, as exemplified by the Wisconsin Idea, is integral to each of the priorities and all these aspects of the biological sciences at UW–Madison are mutually interdependent. We address outreach, therefore, within the three major sections. We conclude the report with a set of crosscutting recommendations that relate to all three priority areas.

### **Research Preeminence**

The University of Wisconsin–Madison has earned a reputation as one of the preeminent biological research institutions in the world. We are ranked highly in many areas across biology—from ecology to molecular biology. We have few barriers to collaboration as demonstrated by the rich array of interdisciplinary programs. Our faculty have terrific success in obtaining competitive funding and bring these resources to the University and the State; the average level of extramural funding in biology is \$260,000 per faculty member annually. Our superb research attracts excellent graduate students. We have a great record of bringing this research together with the issues of the day: ecology with conservation biology; cell biology with disease prevention; structural biology with drug design; gene regulation with improving crop productivity. The University of Wisconsin–Madison has a vibrant, enthusiastic, and dedicated research community that provides a powerful service to the state through the generation and dissemination of new knowledge.

Yet, a 1991 Review of the Biological Sciences (*The Hearn Report*) concluded that, although still strong, biological research activity at Wisconsin, relative to peer institutions, has declined concomitant with a decline in state support and federal research funding. There continues to be evidence of this decline. For example, in UW–Madison ranked 11<sup>th</sup> nationally for total NIH funding; by 1996 we ranked 18<sup>th</sup>. The percent of the NIH budget captured by UW–Madison declined 16% from 1987 to 1996. To reverse this decline, the 1991 report recommended that the Biological Sciences be strengthened through strategic planning, building modern facilities, improving recruitment of faculty and graduate students and, securing new financial resources. Progress toward these goals has been made from 1991 to 1998. Notable examples are the cluster hiring initiative, the new Biotechnology Center and Biochemistry buildings, campus-wide improvements in the recruitment and funding of graduate students, and funding initiatives from agencies such as WARF, the Wisconsin Foundation and the Howard Hughes Medical Institute. These improvements have strongly influenced the vitality of UW Biological Sciences; nonetheless, much remains to be done.

Preeminence in research gives the University of Wisconsin–Madison the edge for quality undergraduate and graduate education and outreach embodied in the Wisconsin Idea. New knowledge is generated here; graduate and undergraduate students learn

from research experiences and interactions with national research leaders. The large numbers of graduate student Teaching Assistants and Research Assistants serve as high quality role models who are close in age to our undergraduates. The tradition of learning, of acquiring new knowledge, is a characteristic of the faculty as well as the students. At the same time, the students give the acquisition of new knowledge on the campus perpetual youth, curiosity, and energy.

The future academic and economic health of the University depends upon enhancing the quality of biological research. Specific recommendations on how this can be achieved follow.

**Students give the acquisition of new knowledge on the campus perpetual youth, curiosity, and energy.**

**(1) Secure major resources necessary to maintain the viability of high quality, biological research.**

Investing significant resources to increase the ability of the faculty and staff to compete for extramural research funds and to attract the best new researchers will have high returns. Specifically, investments are needed to:

- Rebuild the numbers of faculty and staff is required for excellence and efficiency in research and the success of core programs, especially following the precipitous decline in numbers that has occurred from 1993 to 1998.
- Stimulate and support highly innovative research with an endowment dedicated to this purpose, titled “The Millennium Biology Fund”. Set the goal of raising \$1 billion dollars by 2010, to generate sufficient funds to support substantial grants to faculty for research.
- Build and refurbish buildings and facilities that are essential for departments with inadequate space for state-of-the-art research.
- Create the core facilities necessary for modern research, particularly those required for maintaining research animals and plants, field research sites, and central capability in computational biology.

**(2) Develop the strength and intellectual flexibility of research and training programs that cross disciplinary lines in the biological sciences and extend and enhance the departmentally based research and training.**

The existing cross-disciplinary training opportunities on this campus range from formal to informal programs within the biological sciences, and between the biological and the physical and the social sciences. Examples include formal programs, such as the Cellular and Molecular Biology, Neurosciences, Developmental Biology, and Environmental Toxicology graduate programs, in which admissions, recruitment, rotations, and training involve faculty from multiple departments; also, the Conservation Biology and Sustainable Development (CBSD) Masters Program, and the Water Resources Management Masters Program within which the curriculum and affiliated faculty span academic divisions. Other examples are found among the informal programs, such as the Madison Ecology Group (MEG), the Arabidopsis Training group, the Chemical Biology group, and the Behavioral Interdisciplinary Affiliation (BIDA), in which faculty and students from a number of different departments meet regularly for seminars, colloquia, and conferences.

- Expand cross-disciplinary research and training initiatives, such as the recent Cluster Hires. The enthusiasm of the faculty for the cluster-hire initiative was evidenced in the submission of 94 proposals involving almost all departments on campus.
- Enhance integration of the biological sciences and disciplines in the other sciences and humanities. Examples of fertile linkages include the rapidly expanding area of chemical biology, integration of social and economic analysis into technology development, and ethical evaluation of ecosystem management and new biological

technologies such as gene therapy, organismal cloning, and use of fetal tissue for medical research and technology.

- The system must be modified to reward rather than penalize faculty and staff who engage in cross-disciplinary activities even when these activities reduce involvement in traditional departmental activities.

**(3) Develop professional and public forums to assess the roles of biological research and its impact on the environment, health care, the food supply, the economy, and public policy.**

During the next century, expanding knowledge from biological research has the potential of dramatically altering the lives of people worldwide. Emerging issues related to the global environment and sustainability open new research avenues, and research results will influence future environmental policies. The likely beneficial impact of biological discoveries in health care are well publicized, but new knowledge such as the ability to diagnose genetic predisposition to disease raises thorny health care issues with ethical and practical consequences. In the tradition of the Wisconsin Idea, the University should work vigorously to illuminate such emerging issues rooted in biology.

- Direct approaches include the development of courses, conferences, and workshops and the inclusion of ethical, philosophical, and other relevant perspectives in departmental and interdisciplinary seminars.
- Professional training should provide meaningful interfaces between laboratory and fieldwork, bench research and industry, and experimental and clinical applications. One existing example is the Biotechnology Training Program, which requires an internship in the biotechnology industry for all trainees.

**(4) Improve channels for two-way communication between UW researchers and the public.**

Research and its application and stimulation by the people of Wisconsin and the globe are key to the Wisconsin Idea. We have a great tradition in this arena that should be encouraged to flourish. The Wisconsin Idea is nourished by the research excellence of the University, and likewise, research at the university is infused with new ideas by dialogue with the public and other end-users of our research. The direct contact between UW faculty and the public has fostered some of our major scientific breakthroughs, such as the discovery of coumarin, an anticoagulant that was found as the result of a farmer bringing a sample of moldy hay to a faculty member in the Biochemistry Department at UW–Madison. To maintain this fruitful exchange, we must expand the many established connections, such as those provided by UW–Extension, and promote the development of new ones.

- Develop computer-based or other creative new outreach programs to increase communication with the citizenry of the state to promote an understanding of the new developments in agricultural, environmental, or health-related research that might affect their lives or livelihoods. Develop an interactive version of the “WhyFiles” for citizens to request information from the University research community.
- Develop a program parallel to the University-Industry Research Program that would make connections between public needs and university researchers and possibly stimulate new research directions on campus.
- Be responsive to citizen initiatives, such as the numerous restoration experiments on the landscape that involve collaboration among citizens, biologists, and policy makers.

**(5) Increase diversity of the biological science faculty and staff to ensure the fullest possible range of creativity, insight, and scholarship in research and the training of future scientists.**

- Vigorously pursue initiatives to improve recruitment, retention, and climate for

women and other under-represented groups in biology so that the faculty and staff better reflect the composition of the student body and the public we serve. This will contribute to UW–Madison remaining competitive for the best scientists since demographics predict that some of the best recruits will be from groups that are significantly under-represented on our campus. While some advances in recruitment have been made, much remains to be done. Retention and climate issues urgently require attention.

- Form coalitions with other institutions and organizations and a campus center for human diversity to promote discourse, research, and teaching regarding diversity issues.

### Undergraduate Education

Over the past 10 years, there has been an increased demand for biology as a field of study among college students across the country. At UW–Madison, the number of students graduating with biology majors has swelled by 25% while the undergraduate population has shrunk by 7% due to mandated enrollment reductions. In the same period of time, the faculty in biology has been reduced by 10–15% (depending on how “Biology” faculty are defined; see Table 1). Therefore, we have fewer faculty to teach more students in the biological sciences. Given these constraints, it is remarkable that

Headcount of Biological Science Faculty as  
Defined by Divisional Committee Affiliation

	1987	1997	% Change
Biology	315	268	-14.9%
Health-Related	457	437	-4.4%
Total	772	705	-8.7%

No. Biological Science Faculty FTE as  
Defined by School/College/Dept. Assignment

State Funds			All Funds		
1987	1997	% Change	1987	1997	% Change
271.8	247.5	-8.9%	290.4	262	-9.8%
340.2	288.9	-15.1%	432.5	426.2	-1.5%
612	536.4	-12.4%	722.9	688.2	-4.8%

Notes:

1. Headcount is based on the number of faculty who are affiliated with the biological sciences divisional committee. Faculty members in some departments may choose among two or more divisional committee affiliations (e.g., faculty in the School of Nursing may choose either biological science or social studies). In those departments, only the faculty members who chose the biological sciences division are counted.
2. For purposes of determining FTE, those academic departments defined as “Biology” include the following: Agronomy, Bacteriology, Biochemistry, Botany, Dairy Science, Entomology, Environmental Toxicology, Institute for Environmental Studies, Food Microbiology and Toxicology, Food Science, Forestry Ecology and Management, Genetics, Horticulture, Animal Sciences, Nutritional Sciences, Plant Pathology, Soil Science, Animal Health and Biomedical Sciences, Wildlife Ecology, Zoology and some biological centers.
3. Health-related departments are defined as all departments in the following Schools: Medicine, Nursing, Pharmacy and Veterinary L Medicine.

**Table 1:** “Comparison of the Number of Biological Science Faculty Members in 1987 and 1997.” Source: 1987, 1997 October Payroll for faculty FTE and UW–Madison tenure file for headcount by divisional committee. December 1998 Office of Budget, Planning and Analysis.

the last decade has been a time of innovation and excitement in biology education at UW–Madison. The Center for Biology Education (CBE) was formed, five summer Research Experiences for Undergraduates (REU) programs were initiated, advising has improved, increased emphasis has been placed on treating biology teaching as a scholarly pursuit, and forums have arisen for the development and exchange of successful teaching methods.

The future will be punctuated by decisions made by humans that will determine the future of the globe and our species. Conservation and allocation of biological resources, environmental degradation, management of the food supply, population control, global climate change, movement of pests and pathogens of crops, animals, and humans, and applications of genetic technologies will be among the areas that will require major decisions in the next few decades. Given the breakneck speed of biological research, there will also be new areas of global importance that cannot be anticipated now. We must strive to send UW graduates into the world able to deal competently with the issues of the 21st century. Those not majoring in a biological science should be able to acquire basic literacy in evolution, genetics, cell and organismal biology, physiology, ecology, and the human context of biology. Biology majors need an appreciation of the cultural, psychological, and political forces that influence biologically relevant decisions in addition to a solid education in their specific field of biology. Interdisciplinary dialogue should be promoted at all levels. Recommendations for achieving these aims are presented below.

### **(1) Expand laboratory, field, and research experiences for biological sciences majors.**

Every recent report analyzing U.S. education advocates more problem-solving, hands-on, inquiry-based approaches to teaching science at the college level. Our research faculty are uniquely equipped to share the process of scientific inquiry. We propose that diverse mechanisms be instituted to bring undergraduates in biology into the process of discovery. By engaging in inquiry and experimentation, our students will gain an understanding of the process of science as well as critical thinking skills that will aid in many of life's endeavors.

- Expand opportunities for independent research, internship and service experiences that require application of theoretical knowledge to problem solving. To facilitate this outcome, provide all biology majors with ready access to a database of current faculty and staff research projects and information about research and independent project credit options; generate more funds for undergraduate research including training grants and additional Hilldale/Holstrom Fellowships; provide a mechanism to inform faculty of federal grant add-ons for undergraduates; create more biology courses that offer a rigorous research experience.
- Provide students with a diversity of options for engaging in research and applying critical thinking skills to real issues: capstone course research projects, serving as a teaching fellow, internship in government and industry, community service.
- Reverse the trend of loss of lab and field components in intermediate and advanced biology courses by providing adequate faculty, TA and staff support, and facilities.
- Ensure that there are enough high quality introductory biology lab courses to meet the demand.

### **(2) Promote continual improvement in teaching.**

The science education reform movement has revolutionized thinking about what constitutes effective teaching. The explosion of new knowledge in biology, the increase in average class size in biology courses, and rapid change in our knowledge about the

effectiveness of various approaches to teaching all contribute to a need for better communication about successful teaching approaches. Forums at UW–Madison have made a variety of teaching approaches accessible to some faculty and staff and have provided opportunities for everyone to learn from other’s experimentation. To generate more widespread use of effective methods in biology teaching, the following recommendations are presented.

- Focus attention on innovative, successful teaching approaches and on training faculty and staff in their use as new approaches develop and become available.
- Enhance the visibility of and access to forums for learning about the latest research and developments in teaching such as brown bags, seminars, Science House, and CBE.
- Change from assessment methods that rely on student course evaluations to a process that evaluates learning of concepts and application of knowledge.
- Integrate historical and philosophical context and ethical issues into more introductory biology programs to increase their appeal and relevance to students’ futures. Encourage collaboration with faculty in other fields.
- Encourage the use, where possible, of texts and other teaching materials that reflect global human diversity.

**(3) Teach non-majors the fundamental principles of biology needed to deal effectively with the critical issues of the next century.**

- Promote biological and ecological literacy for all undergraduates by increasing the number of high quality non-majors’ courses with lab, field, or other hands-on components.
- Reduce class sizes to improve interaction between students and instructors.

**(4) Bring the basic principles of biology to a broad community.**

Undergraduate teaching is one of the most important mechanisms of achieving the Wisconsin Idea. Generations of undergraduates complete four years of learning and then become members of the State and global community. We aim to provide them the basis for a life of learning and intellectual growth and curiosity. Each year, we graduate approximately 900 students in biology majors who affect the lives of those around them with knowledge and values developed at our University.

While we consider our students to be our greatest contribution to the biological literacy of the state of Wisconsin, we must reach a broader audience and reach our graduates throughout their lives after they graduate from the University.

- Develop an outreach program based on the UW Foundation’s “weekend away” program. This would be a weekend series of programs by UW faculty, staff, and students focusing on timely issues in biology that would be given in various areas of the state over the course of a year. A different program might be developed each year, relying on a broad range of participants.
- Develop broader participation of UW faculty, staff, and students in Science House, a program geared to bringing research to bear on teaching and facilitating exchange of teaching ideas and approaches among members of the UW–Madison community and the rest of the biology teachers of the state (K-postgrad), and develop better linkages with the School of Education to achieve better preparation of biology teachers.
- Continue to support and expand the “WhyFiles,” the nationally recognized science information web site developed and maintained at UW–Madison.
- Develop a few high quality radio and TV documentaries about biology that affects

**Undergraduate teaching is one of the most important mechanisms of achieving the Wisconsin Idea.**

the citizens of Wisconsin. Collaborate with WHA to obtain funding for key projects to educate our own citizens, and hopefully a broader audience, about the critical issues of biology, human health, agriculture, and the environment.

- Distance education should be used where appropriate, but since lab, field, and other hands-on experiences are essential for high quality learning in much of biology, current forms of distance education have limited applicability. Targeted course development grants would stimulate proposals to address the challenges of applying distance education to biology.

**(5) Generate faculty and staff time and other resources necessary for creative, effective teaching.**

In the foregoing sections, changes in the instructional programs are proposed that require increased commitments from the campus. These include: increasing availability of lab and field courses to majors and non-majors; increasing availability of research experiences for undergraduates; increasing faculty and staff time spent on teaching innovation; and investing in learning assessment. These activities will require more faculty and staff time, greater numbers of faculty and staff, and other resources that are in short supply. The stresses on faculty and staff time are substantial, and burn-out of our most productive personnel is a real danger. One recommendation is to increase the flexibility that professors have in fulfilling their annual teaching responsibilities to accommodate their research schedules (seasonal field work, etc.). Laboratory instructional academic staff on 9-month appointments who must spend their unpaid summer time revising curricula, writing lab manuals, maintaining and updating supplies and equipment, etc. should be offered 12-month appointments. But additional personnel will also be necessary to accomplish the above goals.

- We anticipate that an additional 50 positions in biology will be required to begin to meet the educational goals laid out in this report. These would be of four primary types, the first three being permanent positions. (1) Faculty to teach more courses with lab and field components. (2) Laboratory directors or coordinators for new and under-serviced introductory and intermediate lab and field courses. (3) “Floating” introductory biology lecturers capable of providing a semester of teaching relief for a number of introductory biology faculty and staff engaged in course revision, a particularly heavy load of undergraduate research, or course development. Since these individuals would have expertise in and commitment to improving biology education, they would also be a resource for facilitating the introduction of new teaching approaches and materials into courses. (4) Temporary instructional positions to provide similar relief to faculty and staff in upper level courses. Funding for type four positions could be moved among departments, so that a number of faculty and staff had access to these “mini-sabbaticals”. While positions of type one would be filled by faculty, the remaining three types would be academic staff appointments. If half of these instructional positions were academic staff, those 25 positions would represent a \$1.5 million commitment and an equivalent number of faculty would require an additional \$2.5 million. The need for such an increase is critical and is simply a start at rebuilding biology since it would still not bring the number of biological sciences faculty back to the level of 1988, before the surge of interest in biology among undergraduates. Additional TA support for new lab and field components of courses will be required as well.

Mechanisms for tying teaching in the general biology curriculum to critical research hires should be considered. For example, if a new fund was generated for hiring faculty to teach in general biology courses, the Provost’s Office might provide a 0.5 FTE dedicated to teaching the needed courses to a college or department that would match it with a 0.5 FTE to hire a faculty member to fill a research need. In this way, research priorities and undergraduate teaching needs

- together would drive these faculty hires.
- To promote the values placed on undergraduate and outreach education embodied in this report, the UW Foundation and faculty, staff, and administrators should raise funds for endowed professorships that are given to faculty with a demonstrated commitment to undergraduate and outreach education as well as excellence in research. These professorships would free active researchers from some grant writing and enable them to direct more creative energy to undergraduate and outreach education.
- Support faculty mentoring of undergraduate research by providing release time and other resources. Ensure that credit accrues to faculty and to programs, as has been done effectively in Bio152 by having students in 152 sign up for independent study credit with the faculty mentor.
- To facilitate the efficient coordination of continuing modernization and improvement of the teaching program in biology, the Office of the Associate Vice-Chancellor for Undergraduate Education, the Center for Biology Education, or some other facility should provide a clearing house for teaching materials, grant opportunities in teaching, and on-going activities affecting teaching, course revision, curriculum development, etc. across campus.
- We must find ways to modernize lecture halls and other classrooms used for biology instruction, create new instructional labs, and continue the excellent Instructional Lab Modernization Program to update existing facilities.
- All levels of the university must recognize and reinforce faculty efforts in undergraduate education. Recognition and reinforcement can be accomplished through hiring, tenure and promotion processes, merit review, letters of recognition for programs of value, and efforts by campus administrators to work with federal funding agencies to encourage them to recognize and support undergraduate biology education.

**Upon completion of their training at UW–Madison, we expect graduates to be responsible and dedicated individuals who are flexible and adaptable to new ideas and good educators who articulate their ideas and opinions in an effective manner.**

## Graduate Education

Excellence in the education of future professionals in the biological sciences is central to our vision for responsible biology. Upon completion of their training at UW–Madison, we expect graduates to be responsible and dedicated individuals who are flexible and adaptable to new ideas and good educators who articulate their ideas and opinions in an effective manner. We expect them to communicate their thoughts succinctly yet comprehensively, and to be well versed on ethics in the conduct of research and science as well as the considerations specific to their discipline. We expect them to be trained in logical thought and the methods of scientific inquiry, conversant with the tools of technology, capable of learning new skills independently, and passionate about the content that represents depth and breadth in their discipline. We expect that they will be able to speak about their work to laypeople in terms appropriate to the situation and work effectively in interdisciplinary teams. Having acquired these skills, we expect them to become leaders in their chosen fields by embarking upon their careers with goals not only for productivity and success but also for citizenship and respectful collegiality.

Census projections suggest that by 2030 over 40% of the U.S. population will be non-Caucasian including 18% Hispanics, 13% African Americans, 8% Asian and Pacific Islanders and 1% Native Americans. Women comprise 51% of the U.S. population. To stimulate the commitment of all populations to the concepts and practice of responsible biology, UW must adopt recruitment and educational programs that engage the interest of these groups in biology and foster the desire of individuals within these groups to pursue careers in biological sciences.

**(1) Continue UW's tradition of recruiting and training top-notch graduate students through the efforts of excellent faculty, broad programs, and outstanding resources.**

Generate new mechanisms for funding graduate training. Pursue innovative initiatives for block funding from industry, the UW Foundation, and WARF. Increase the number and attractiveness of fellowships available.

Aggressively pursue the initiatives proposed in the Research Preeminence section of this report to continue to provide a superb research environment for graduate training.

**(2) Improve graduate recruitment and focus.**

The nationwide decline in applications by outstanding students has resulted in keen competition for qualified applicants. It is imperative that excellent faculty and broad, interdisciplinary programs be maintained. These programs and faculty must be attractive, readily identifiable, and accessible to potential applicants.

- Improve ability to attract outstanding graduate applicants through enhanced recruitment strategies incorporating mechanisms to improve minority recruitment. For example, expand linkages with historically black colleges and historically Hispanic colleges and reach into the undergraduate years or below to identify and nurture promising students from special populations into graduate programs and toward careers in biology.
- Facilitate graduate student access to coherent, current information concerning the array of graduate training programs through: the use of state-of-the-art, linked Internet sites; a Graduate School biology clearinghouse (literal and virtual) that provides access to information about all training programs, professors, research, clinics, other educational opportunities, and the campus and community; and, visibility through traditional resources such as Peterson's Guide.
- Attract applicants to the UW with multidisciplinary opportunities for research rotations, laboratory and clinical experiences, training and experiences in teaching, solid funding, and a strong national and international reputation. Promote umbrella and broad program arrays where appropriate.
- Insure adequate resources and infrastructure so that faculty and programs remain competitive for training and research grants. One strategy is to develop an electronic database for faculty bio-sketches, other support, and environment and resources descriptions to facilitate submission of research and training grant applications.
- Develop more orientation and research talks by faculty as well as opportunities for social interaction with current students for potential graduate applicants.
- Evaluate recruitment programs and share successful strategies.

**(3) Establish effective educational programs for modern graduate training.**

Research is and will remain the core for graduate training. However, given the increasingly complex landscape of the workplace, there are skills in addition to the tools for scientific work that our graduates need to be effective as university or college faculty, clinicians, or other professional biologists in the private sector and government. Some of these activities might be perceived as lengthening time to degree. We suspect they will have the opposite effect, by invigorating students through quicker clarification of individual career goals.

- Develop or improve training opportunities in: grant writing; leadership development; teaching and curriculum development; ethical, historical, and philosophical perspectives; cultural and professional diversity; information technology; and personnel and budget management. Commit resources toward developing and coordinating these enterprises across departments.

- Encourage graduate students who are or will be Teaching Assistants to participate in the Teaching Certificate Program and courses on teaching to enhance both their own skills and learning in undergraduate biology courses.
- Improve access to and development of interdisciplinary programs and opportunities that will bridge laboratory, field, and clinical training with private sector and government internships such as those in the Biotechnology Training Program.
- Build vigorous and organized outreach opportunities for graduate students. These could be coordinated through the Office of Outreach Education, which would match students with appropriate needs. One activity might be a graduate student speakers bureau. Another might be a biology hotline on which the public could ask questions that the graduate students could research and respond to. Graduate students might serve on this hotline for short periods on a rotating basis. This type of experience could expose students to the important uses of scientific knowledge, would have a positive impact on the community, and would teach the principles of responsible biology.
- Continue UW's tradition of recruiting and training top-notch graduate students through the efforts of excellent faculty, broad programs, and outstanding resources.

#### **(4) Establish an optimal, responsive environment for graduate and postdoctoral training.**

We need to increase diversity of the graduate student population and provide an environment in which a diversity of students can succeed. Success in training diverse students demands a climate that is tolerant of ideas and personal styles as well as accommodating to the varying needs of a diverse workforce and student body. This is critical to our future as a responsible biology research and training campus. We must have access to the best students and, given the demographics of the future, many of those will be in currently underrepresented groups. In addition, we will be more successful both in enhancing the intellectual rigor of the biology we do and in communicating with the public about that biology if the biological sciences community reflects the gender and ethnic composition of society.

- Develop approaches for flexible degree timelines, sick child and on-site child care, accommodations for returning adult students, and other strategies to promote the success of all students. Maintain high quality benefits such as health care, housing, and a vibrant community to live in.
- Establish departmental, program, college, and graduate school level mechanisms, such as designated graduate student ombudspersons, to assist students in solving problems and learning how to function effectively on campus.
- Devise department-specific goals for improving recruitment and graduation rates of women and minority students and share successful strategies.
- Make concerted efforts to increase the visibility of women and minority scientists by increasing the number of women and minority speakers at research conferences sponsored by the UW. Provide the intellectual space for feminist and ethnic perspectives on science to play a role in the campus dialogue about science and the people who do it.
- Clarify university policies on employment conditions, benefits, grievance procedures, and career advising for postdoctoral positions.
- Clarify and enforce policies on sexual harassment, gender discrimination, racial discrimination, and scientific misconduct.

Provide opportunities for appropriate mentoring for all students. Provide special opportunities for networking among and mentoring for minority and women students across disciplines.

## Crosscutting recommendations

1. As a land-grant university we have a responsibility to bring our science to the people of the state and the world. We must reinvent the Wisconsin Idea in a manner that educates, engages, and enthuses citizens about issues in biology and environmental sciences. We must develop efficient mechanisms for sharing what we know and for learning what the citizens of our state know and want to know. The future of the University, and indeed, the health of our people, food supply, and planet depend on a dialogue between biologists and the public. We must adjust our outreach programs to accommodate the reality of changes in Extension, the demographics of the state, and biology itself. As we build new outreach programs, we must embrace and represent the breadth of modern biology research and education. These programs must involve both basic and applied researchers, since in modern biology the lines between basic and applied research are blurred and we often cannot anticipate the source of new fundamental knowledge or applications.
2. We must use and protect the natural resources currently under our control for biology research and teaching. The Madison campus is richly endowed with natural areas that provide superb field sites for biology research, teaching, and outreach. Vigorous efforts should be made to protect and enhance the Arboretum, the Campus Natural Areas, and the campus wet space and greenspace to provide a model of environmentally responsible management of urban natural areas, to maintain excellent, proximal training material for biology and environmental sciences, and to maintain our unique aesthetic campus environment. These areas should be promoted and used more fully for research projects, classroom and field education, and outreach to the public on environmental issues. The staff and resources required to protect, preserve, and expand the use of these natural areas should be a high priority for the campus.
3. The lack of faculty and staff time is one of the most acute problems at the University. Efforts must be made to protect time for teaching, research, and outreach. To accomplish this and increase the efficiency of governance, the committee structure at the University should be reviewed and revised to reduce the overall load of committee work and perhaps make more use of staff members who are not currently involved in committee work. The total number of committees and the number of members of each committee could be reduced to protect faculty and staff time and energy for scholarly work. This effort must be balanced with the requirements of strong, responsible shared governance.

To increase the efficiency of the University, we need a simple, rapid mechanism to help staff and faculty navigate the complex and often confusing structure of the university. The goals should be to (1) solve specific problems quickly and (2) identify generic barriers to scholarly efforts that should be addressed. Provide a “suggestion box” (virtual or literal) for faculty, staff, and students to send ideas or problems to a central office to be addressed. The suggestion box should be managed by the University Committee and the Provost’s office and should be widely advertised and easy to use.

4. A universal theme throughout the future directions for the biological sciences at UW is that of diversity: diversity across disciplines stimulating biology to stretch its dialogue into the social sciences, physical sciences and humanities; diversity within the biological sciences from molecules to the biosphere fostering collaborative problem solving; diversity in the mosaic of talents of faculty as educators, researchers, service-providers, and clinicians; diversity in the gender, ethnicity, and cultural heritage of the students and faculty. Commitment to enlarging the perspective of biology is critical, but in order to be great at the institutional level,

UW must ensure that each individual is encouraged to achieve their full potential. This will require an understanding and documentation of the problems, creative solutions, and new ways of doing business in the laboratory, the classroom, and beyond. The faculty, staff, and administration of the UW–Madison campus are charged with creating a climate in which all individuals feel accepted and free to contribute their talents regardless of age, gender, physical abilities or traits, race, religion, national origin, or sexual orientation. Responsibility in biology starts with equity for people on the entire campus.

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