

ISSUES AND RECOMMENDATIONS FOR UNDERGRADUATE INSTRUCTION IN THE BIOLOGICAL SCIENCES AT UW-MADISON

Final Report 5/23/95

I. INTRODUCTION

In response to a request from Associate Vice Chancellor Virginia Hinshaw and the Council of Biology Deans (now called the Administrative Council for Biological Sciences), the Undergraduate Biology Education Committee (UBEC) began a study of undergraduate biology instruction at UW-Madison. The purpose was to identify issues important to biology education across campus that transcend departmental and college boundaries. We hope this process will lead to a vision for undergraduate biology at UW-Madison that enables departments and other groups responsible for decision making to evaluate their programs in light of campus-wide concerns. This document focuses on programs designed for biological science majors. A separate report summarizing a forum held on January 19, 1995 to discuss courses for nonmajors has been sent to participants and to all departments teaching these courses.

Our initial survey of the state of undergraduate biology programs on the Madison campus reveals a set of healthy and high-quality programs offering a great deal of choice to the undergraduate. It has also uncovered some problems and challenges in a number of areas:

- The large number of majors in the biological sciences (over thirty), although a strength of the campus, is often a source of confusion to students.
- Similar majors often have course requirements different enough to make movement between majors difficult even in the first two years.
- There exists an unevenness in the quality and quantity of biology advising both between and within colleges.
- Differing degree requirements between colleges sometimes get in the way of students' educational goals.
- Some core biology courses do not have the necessary capacity to accommodate all students who need them.
- There are not enough upper level laboratory and field courses.
- Interest in biology is increasing while resources are decreasing.

Several of these challenges are discussed in the following sections.

This final report was prepared after circulating a draft to biological science departments and other interested parties and making it available on WisInfo and World Wide Web. We also held three town meetings for faculty and staff and a meeting for students. UBEC considered comments from these meetings as well as comments from individuals and formal departmental responses and included many, although not all, in this final report.

II. BIOLOGY: UNITY VS. DIVERSITY

The discipline of biology is broader than other disciplines with which it is often compared. Biological science is similar in scope to physical science. However, an entering freshman often sees biology as one subject on a par with chemistry, physics, or geology. Although this may be an accurate perception at the level of an introductory course, it underestimates the broad range of biology as a discipline. While each major has a dedicated group of faculty behind it, no one is currently charged with addressing curriculum issues in undergraduate biology education overall.

Recommendation 1. We urge the formation of a campus-wide biology curriculum committee as a part of the Biological Sciences Division Executive Committee.

This committee would be advisory to the Administrative Council for Biological Sciences regarding issues of undergraduate biology education on the Madison campus. We recognize that the primary authority for curriculum resides in departmental executive committees, but there is a need for some group to take an overview of biological education on campus and address issues that transcend departmental and college boundaries.

Recommendation 2. We urge that the current Biology Advisor position be maintained.

While some students who are interested in biology come to campus with a specific major in mind, many look for a Department of Biology and its corresponding major and find instead a bewildering array of choices, each with a different set of requirements. Many do not even know which college they should be in since this often is determined by their major. They wish to postpone deciding upon a specific major until they have had more coursework, and in the meantime, feel lost and confused.

The current Biology Advisor has filled a critical need in helping students find their way. She provides information about biology programs and majors to students and parents, participates in SOAR, develops mechanisms for involving faculty in pre-major advising, keeps undergraduate advisors informed of up-to-date information about departmental requirements, programs, and research opportunities, works with the Center for Biology Education to develop and distribute publications for undergraduates and prospective students, and maintains a resource center to provide current information about majors, related programs, research and job opportunities, scholarships, and internships. In 1994, the Biology Advisor handled a total of 914 visits and 700 telephone calls related to advising in biology.

A. Core Courses for Biology Majors

It would be helpful if the early requirements of all biological majors, or at least a small number of sets of majors, were similar enough that options are not closed too soon. Students want to know that courses they take will not leave them at a disadvantage or cause them to be in college five years or more. There are unifying themes in biology and similar training required for many biological disciplines. Some of the current differences in requirements among similar majors may reflect historical precedent rather than substantive differences.

Recommendation 3. We urge the establishment of a small number of unified freshman/sophomore course requirement options for biological science majors.

We believe that most of the biological majors on campus could be partitioned into a small number of major groupings within each of which first and second year general course requirements are unified. For example, the following groupings come immediately to mind: plant sciences, animal sciences, cellular & molecular sciences, ecology and population biology. Whatever the groupings might be, a simplification of introductory course requirements would simplify advising, make it easier for students to switch majors, and possibly effect a rationalization and reduction in the number of introductory courses needed.

The Figure and Table included with this document are attempts to depict relationships among biological majors and current requirements in core science courses. Almost all biological majors require some mathematics and a year each of chemistry and introductory biology; many require genetics and additional mathematics and chemistry. It is clear that there already exists a certain degree of uniformity of requirements within certain subsets of the biological majors. We believe

that first and second year course requirements could be further consolidated without compromising rigor.

Introductory Biology

There are currently three main ways that students satisfy their introductory biology:

1. Botany/Zoology 151/152, a one year sequence,
2. Zoology 101/102, Introductory Zoology sometimes combined with, or replaced by Botany 130, Introductory Botany, and
3. Biology Core Curriculum. Biocore occupies a unique niche as an honors introductory-to-intermediate two year sequence. It serves its students well and is considered to be at optimal size.

Recommendation 4. We urge biology departments who desire for their majors a year of introductory biology to recommend Botany/Zoology 151 and 152 or Biocore as the preferred introductory route.

Many of the majors that attract large numbers of students, such as Biochemistry, Molecular Biology, Biological Aspects of Conservation, Genetics, and Bacteriology are best served by 151/152. In addition, students not certain of which biological major they will ultimately choose are best served by 151/152 because of its breadth of coverage. Zoology 101/102 and Botany 130 serve students needing a more focused, shorter introduction to either animal or plant biology.

Recommendation 5. Increase support for Biology/Botany/Zoology 151/152 so that it can expand to accommodate all sophomores who wish to take it.

Access to Botany/Zoology 151/152 has been limited in the past. This had the effect of forcing students to take less appropriate courses or to delay introductory biology until their junior year. An expansion is now underway; this will require the participation of faculty from many departments across campus.

Recommendation 6. Rename Botany/Zoology 151/152 as Biology 151/152 and list it in the cross-college section of the timetable as well as under Botany and Zoology, with Zoology remaining the primary department.

Botany/Zoology 151/152 is a *biology* course and its name should reflect that fact. The name change will emphasize its interdepartmental nature and make it easier for biologists from all across campus to identify with the course.

Chemistry

Essentially all majors require one semester of general chemistry and most require two. Biological science majors should take chemistry immediately upon arrival at UW-Madison. Most biology students take Chemistry 103/104; 109/110 is recommended for those with strong backgrounds in chemistry. Many majors also require organic chemistry and some require analytical chemistry.

Recommendation 7. We wish to encourage the Chemistry Department committees discussing curricular reform to consider increasing the use of biological examples to demonstrate chemical principles in the introductory chemistry courses.

We urge the biological community to work with the Chemistry Department in helping students make connections between biology and chemistry.

Mathematics

The Mathematics Department holds strictly to the results of placement tests in determining class choice. Math requirements for biological science majors vary. Undecided students can keep most options open by taking Math 221/222. Courses dealing with probability and statistics are also important for biology majors. Many biologists would like students to have a one year sequence which includes calculus, probability, and statistics.

Recommendation 8. We support the plan of the Mathematics Department committees discussing curricular reform to develop of a one year sequence covering calculus, probability, and statistics.

We urge the biological community to work with the Mathematics Department in designing courses that emphasize the relevance of particular quantitative skills to biological problems.

Physics

Most biology majors require a year of physics. The non-calculus course, Physics 103/104 is acceptable for many majors, while the calculus-based 207/208 leaves more options open.

Genetics and Ecology

Genetics is a central part of biology. Most biology majors require genetics and this should be available to all juniors who need it. Similarly, ecology is required for many biology majors. Ecology should also be accessible to all juniors who need it.

Recommendation 9. Genetics 466 and Botany/Zoology/Forestry 460 (Ecology) should have sufficient sections to accommodate all juniors who need them.

It is important that students be able to take these courses without delays due to inadequate availability. Ecology 460 was recently doubled; further increases may be needed.

B. Upper Division Courses and Majors

UBEC attempted to model the wealth of biological majors at Madison with the attached figure. This figure should serve two purposes. First, it can emphasize to students the long-term implications of taking or avoiding specific courses in physics, chemistry, and mathematics. Second, it should serve to clarify the natural groupings among existing majors. In some cases, these groupings should lead faculty to analyze whether small differences in some majors are worth retaining (particularly in view of the resources required). A major consideration should be consolidation of majors and of specific courses. We commend the plant sciences departments for initiating discussions on these issues.

The large number of majors (over thirty) and their distribution among several colleges is confusing to most students, who do not understand why particular majors reside in particular colleges. We would like to make it easier for students to move between majors and colleges if they so choose.

Recommendation 10. We urge the creation of a new major called Biology available in both CALS and L&S.

The proposed biology major would serve two purposes. On the one hand, it would be a home for students before they are ready to choose more specialized majors. (Students who wish to start in a more specialized major would be encouraged to do so.) On the other hand, the Biology major would also be a rigorous major in its own right leading to a degree in Biology. This option should be available to students in both CALS and L&S. This would reduce one of the differences between the

two colleges. (In CALS, students are required to declare a major upon enrollment, whereas in L&S, students are expected to declare a major in their second or third year).

Requirements for the Biology major are currently under discussion. In our opinion, the major should be comprehensive and should require at least one year each of chemistry, math, introductory biology (151/152 or Biocore), and physics. A semester or more of organic chemistry, ecology (460), genetics (466), and advanced laboratory or field courses should also be required. These requirements would assist students in keeping their options open and also prevent the Biology major from becoming simply a path of least resistance to a degree.

Recommendation 11. We urge that Genetics (currently a CALS major) and the Biological Aspects of Conservation (currently an L&S major) be available as both CALS and L&S majors, just as Biochemistry and Bacteriology are, and the proposed Biology major would be.

Recommendation 12. We urge that CALS and L&S enter into negotiations with the goal of reducing academic barriers to cross-college biological education.

Although we recognize each college's need to implement and promote its own educational philosophy, differing degree requirements can sometimes get in the way of students' educational goals. The inability of L&S students to take a second major in CALS and the 100 credit rule are two examples of rules that should be reexamined. The time when L&S needed to protect its students from educationally inferior courses in a College of Agriculture has long since passed into history. Such restrictive rules are especially onerous to biology majors in L&S because, today, a large fraction of biology on campus resides in CALS and the Medical School.

Recommendation 13: We urge that departments receive the resources needed to offer the laboratory and field courses that are necessary and appropriate for specific degrees.

A significant problem faced by upper division students is lack of enough intermediate to advanced laboratory and field courses. Comparative Anatomy Laboratory (Zoology 431), for example, had 300 students vying for 100 places this past year. Most biological sciences require hands-on lab or field experience at both the introductory and intermediate/advanced levels, but laboratory courses face difficult times when resources are scarce. Many have already been abolished.

The number of students needing upper level laboratory and field courses is significant, since about one-fifth of each class graduates with a biology-related major (1,378 in 1993-94, the most recent year for which we have statistics). We are not presently meeting the current demand for upper level labs, and we anticipate an even greater demand in the future, due to the increased interest in biology which has been occurring.

III. IMPLEMENTATION

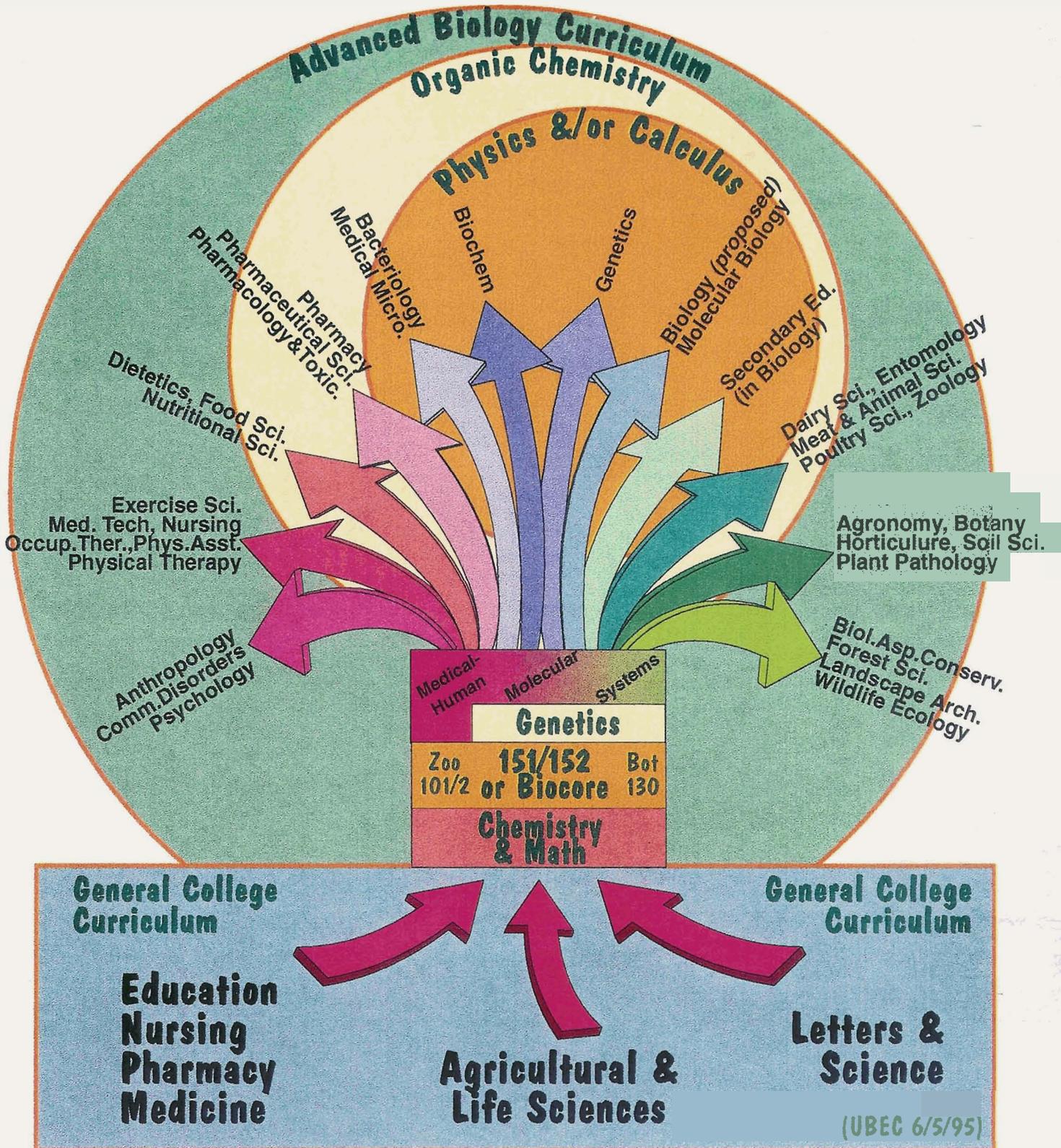
The University is bracing for declining budgets in the future and this will impact how quickly resource-intensive reforms can be made. Some of the recommendations made here do not require additional funding. In looking at funding cuts, it will be important to have a clear vision of the connections among biological programs across campus. With input from faculty this report should be useful to those who allocate resources so that such allocations can be done in the best interests of the University. If some economies result from the recommendations for consolidation addressed by this report, we might mitigate some of the deleterious effects of the past underfunding and potential future underfunding of biological sciences at UW-Madison.

Many of the suggestions made here will require action by groups at several levels: individual faculty, departmental committees, Deans, the Divisional Committee, and even the Chancellor. Whatever the level of decision-making, the question of quality undergraduate biology education is a campus issue and must be addressed by the whole biological community. We hope that departments, college committees, and other governing groups will find this report a useful overview as they make decisions.

Tom Sharkey, Botany, Chair
Deric Bownds, Zoology
Carter Denniston, Genetics
Donna McCarthy, Nursing
(representing health sciences)
Jack Rutledge, Meat and Animal Sci.
(representing agricultural sciences)
Don Waller, Botany
(representing environmental sciences)

Barry Bavister, AHABS (Bot/Zoo 151/152)
Ann Burgess, Biocore
Paul Friesen, Biochemistry
Ann Palmenberg, AHABS (liaison to BSPAC)
Gary Roberts, Bacteriology
Frank Siegel, Biomolecular Chemistry
(representing health sciences)

Overview of Current Majors in the Biological Sciences at the UW-Madison



CURRENT MATH AND SCIENCE REQUIREMENTS FOR BIOLOGY MAJORS AT UW-MADISON (Draft: 3/28/95)

MAJORS	General Chem.	Organic Chem.	Anal. Chem. ¹	Physics	Calculus	Statistics	Comp. Science	Genetics
Biol. Aspects of Cons.	○							
Forest Science (ANR)	○				○	○	○	
Landscape Arch. (ANR)	○				×	×	×	
Wildlife Ecology (ANR)	○					○	○	○
Agronomy (ANS)	●	○	○	●	○			○
Botany	●	○						
Horticulture (ANS)	●	▲	◆	●	◆×	×	×	○
Plant Pathology (ANS)	●	○	○	●	○			○
Soil Science (ANS)	●	*▲	◆	●	*×	×	×	
Dairy Science (ANS)	●	▲	◆	●	○	○		○
Entomology (ANS)	●	▲	◆	●	◆×	×	×	
Meat/Animal Sci.(ANS)	●	●	◆	●	◆	○		○
Poultry Science (ANS)	●	▲	◆	●	◆×	×	×	
Zoology	●			●				
Sec. Education, Biology	●			●				○
Molecular Biology	●	●	○	●	●			○
Biology (Proposed) ²	●	?	?	●	?	?	?	○
Genetics	●	●	◆ ³	●	○			○
Biochemistry	●	●	○	●	●			
Bacteriology	●	●	◆	●	◆×	×	×	○
Med. Micro. & Immun.	●	○	○					
Pharm. Sciences	●	●		●	○			
Pharm. & Toxicology	●	●	○ ³	●	○	○		○
Pharmacy	●	●		●	○			
Dietetics	●	○	○ ³			○		
Food Science (ANS)	●	●	○	●	○	○		
Nutritional Sci. (ANS)	●	●	○	●	×	×		○
Exercise Science	●	○		●	○	○		
Medical Technology	●	○	○					
Nursing	○							
Occupational Therapy	○					○		
Physical Therapy	●			●		○		
Physician Assistant	●							
Anthropology								
Comm. Disorders						○		
Psychology						○		
Pre-med (not a major)	●	●		●				

NOTE: NOT ALL OPTIONS FOR EVERY MAJOR ARE SHOWN. ANS = B.S.-Natural Sciences. ANR = B.S.-Natural Resources.

- Two semesters required, ○ One semester required, ▲ Either one semester of organic or advanced physics, ◆ Either analytical chemistry or one semester of calculus, * Depends on specialization, × One course from calculus, statistics or computer science.

¹ Analytical Chemistry (Chem 221 or 223) is not required for students who complete Chemistry 110.

² Requirements for the proposed Biology major are currently under discussion.

³ Genetics requires Chem 221, Math 222 or Statistics. Pharm/Tox requires Phmceut 324, Chem 221 or Chem 223. Dietetics requires either Food Sci 310 or Chem 221.