MOTION:

Motion from the Academic Program & Curriculum Committee (APCC) to approve the proposal for an undergraduate major in Biochemistry in the School of Letters and Science.

RATIONALE:

The Chemistry and Biological Sciences departments and the College of Letters & Science did an excellent job in documenting the need for this program. The APCC expects this to be a high quality program from these two strong departments which further enhances their ability to attract extramural funding.

Members - 2000-01 Academic Program & Curriculum Committee

Dale Buechler
Patricia Cobb
Scott Emmons
Suzanne Falco
Thomas Holme
Alan Horowitz

Bonnie Kennedy
Sunwoong Kim
Russell Lambrecht
Janet Lilly
Jeffrey Merrick
Robert Moore

Barbara Morgan
John Ndon
Peter Sands
Fattah Shaikh
Fran Stanat
Ronald Weber, Chair

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Recommendation of the Department of Chemistry and the L&S Course and Curriculum Committee to Approve a Plan to Implement a Major in Biochemistry

Recommendation:

That the plan to implement a major in biochemistry, as outlined below, be approved by the L&S Faculty.

Approved: L&S Course and Curriculum Committee, December 1, 2000
L&S Faculty, February 8, 2001

Plan to Implement a Major in Biochemistry

1. PROGRAM IDENTIFICATION

1.1. Title of Proposed Program: Major in Biochemistry
1.2. Department or Functional Equivalent: Chemistry
1.3. College, School, or Functional Equivalent: College of Letters and Science
1.4. Timetable for Initiation: Fall 2001

2. CONTEXT

2.1. History of Program: The UW-Milwaukee Department of Chemistry currently offers a major in chemistry and the American Chemical Society approved Course in Chemistry Degree Program. The former of these has two options: the standard chemistry major option and a biochemistry option developed to cater to students planning further study in biochemistry, molecular biology, or medicine. The biochemistry option differs from the standard chemistry option in that some of the chemistry courses required for the standard option are omitted and, in their place, courses in biochemistry and biology are required. The biochemistry option, however, retains the math, physics, and computer programming requirements of the standard option.

2.2. Instructional Setting of Program: The proposed biochemistry major is intended to augment existing academic programs while fully utilizing the strength the Chemistry Department has in biochemistry (currently approximately 25% of Chemistry Department faculty members are biochemists). It also is designed to closely match the requirements of biochemistry majors at other peer institutions.

2.3. Relation to Mission Statement and Academic Plan: The three relevant parts of the UWM Mission Statement and responses to each are as follows:
Part 1

To fulfill its mission as a major urban doctoral university and to meet the diverse needs of Wisconsin's largest metropolitan area, the University of Wisconsin-Milwaukee must provide a wide array of degree programs, a balanced program of applied and basic research, and a faculty who are active in public service.

The introduction of a major in biochemistry will provide for UWM students a curricular option that prepares them for a rapidly growing sector of industry and academia. This objective lies in accord with the above statement as it "meet(s) the diverse needs of Wisconsin's largest metropolitan area" by offering preparation for vocations in biological chemistry.

Part 2

To develop and maintain high quality undergraduate, graduate and continuing education programs appropriate to a major urban doctoral university.

The biochemistry major is directly allied with this part of the Mission Statement. The increase in departmental majors will auger well for biochemical investigation in the chemistry department as a consequence of the requirement in the proposed degree for original research under the supervision of a faculty member (vide infra). The graduates of this program subsequently will contribute to the "technological development" of southeastern Wisconsin by direct application of their knowledge and skills in industries that require biochemists in their work force.

Part 3

To establish and maintain productive relationships with appropriate public and private organizations at the local, regional, state, national and international levels.

The purpose of the biochemistry major is, thus, to allow UWM to produce graduates for a rapidly developing job sector in Wisconsin. Ultimately, the introduction of UWM biochemistry major graduates into this job market will strengthen ties to industry at the state and national levels by showcasing quality UW-Milwaukee graduates in a high-tech arena, an outcome in total congruence with the Milwaukee Idea. Moreover, one of the emerging sectors of development in Wisconsin and surrounding area is biotechnology. In a statement from the Council of Great Lakes Governors 1999, it was announced that "with leading biomed/biotech companies such as Eli Lilly, Upjohn, Procter & Gamble, Monsanto and others in the region, the Great Lakes states are poised to significantly improve their research and commercialization efforts in this area if a concerted, coordinated effort is made". Furthermore, in a 1999 report commissioned by Forward Wisconsin Inc. (chaired by Governor Tommy Thompson) and prepared by Wadley Donavan Consultants, the surprising degree of biotech opportunity in Wisconsin was identified.

3. NEED

3.1. Comparable Programs in Wisconsin: Currently, UW-Madison and UW-Eau Claire offer comprehensive biochemistry majors. The UW-Madison program is regarded as one of the premier biochemistry majors in the country. For this reason, the structure of this proposed UW-
Milwaukee biochemistry major has been based, in part, on the UW-Madison program. The majority of UW system campuses offer a standard chemistry major with a biochemistry option as is currently available at UW-Milwaukee. The only exception is UW-River Falls, which offers a major in biotechnology. Outside the UW system, Marquette University offers a major in molecular biology. Given the prominent role of this institution in higher education in south east Wisconsin, it is fitting that the residents of the major metropolitan center in the state have adequate access to this course of study through UW-Milwaukee (Note: the above description does not include specialized programs offered by liberal arts colleges in Wisconsin).

3.2. Comparable Programs Outside Wisconsin: There are a number of opportunities to secure a biochemistry major outside Wisconsin. A list of the Biochemistry programs available in Wisconsin and neighboring states appears below (the name of the major offered appears in parentheses). Of these institutions, currently only the University of Minnesota offers reciprocity for University of Wisconsin students. It can be seen that Wisconsin residents have only two options to obtain a major in biochemistry within the state of Wisconsin.

**Wisconsin**
- University of Wisconsin-Madison (biochemistry)
- University of Wisconsin-Eau Claire (biochemistry & molecular biology)

**Minnesota**
- University of Minnesota-Twin Cities (biochemistry)
- The College of St. Scholastica (biochemistry)

**Illinois**
- University of Illinois-Urbana-Campaign (biochemistry)
- The University of Chicago (biological chemistry)
- Rockford College (biochemistry)
- Illinois Institute of Technology (molecular biochemistry and biophysics)
- Knox College (biochemistry)

**Michigan**
- University of Michigan-Ann Arbor (biochemistry)
- University of Detroit-Mercy (biochemistry)
- Oakland University (biochemistry)
- Northern Michigan University (biochemistry)
- Eastern Michigan University (biochemistry & professional biochemistry)
- Andrews University (biochemistry)

3.3. Regional, State and National Needs: The Bureau of Labor Statistics predicts a 35% increase in biochemical scientist positions in the next ten years. This rate of growth well exceeds the average rate of growth for all other professions. Thus, there is an ongoing need for universities to graduate students proficient in biological chemistry.

3.4 Student Demand—Future Enrollment: In the past eight years, 42 out of a total of 87 UW-Milwaukee chemistry major graduates have taken the biochemistry option and the available data indicate that 85% of these currently are employed in a biological field. This serves as a testament to the marketability of such skills in the workplace. The continuing sentiment from students who talk with the biochemistry faculty members is that there is a strong demand for such a major in
this institution. On the basis of the above data and anecdotal evidence, it is expected that as many as 20 students will graduate with a major in biochemistry on an annual basis within two to three years of the program's inception.

4. PROGRAM DESCRIPTION AND EVALUATION

4.1 Objectives: There is little doubt that biotechnology has become one of the fastest growing areas of research in both industrial and academic settings. The primary reason for this growth has been the dramatic increase in (and marketability of) therapeutics in the last two decades. During this period, mortality from heart disease has dropped by 36 percent, death rates from stroke have decreased by 50 percent and improved treatments and detection methods have increased the relative 5-year survival rate for people with cancer to 60 percent. With an aging population, the development of new therapies is ongoing and highly profitable. Approximately 55 percent of biotechnology firms are health care related and this sector of the industry employs 70 percent of those in the biotech field. The growth in biochemical research in academia has been equally remarkable. The National Institutes of Health budget has grown to more than $15.6 billion in 1999, 80% of which is directed toward basic research in the biological field.

The proposed biochemistry major is intended to offer UW-Milwaukee students comprehensive preparation for a career in biochemistry research in either industry or academia. The new major will bring the UW-Milwaukee biochemistry requirements further inline with those of other peer tertiary institutions by reducing the total chemistry (non-biochemical), physics, and math requirements while increasing the number of credit hours in biochemistry and biology. The proposed requirements closely match the recommendations of the Federation of American Societies for Experimental Biology (FASEB) and the American Society of Biochemistry and Molecular Biology (ASBMB) for the academic content of biochemistry majors.

4.2 Curriculum:

Proposed Biochemistry Major

General Chemistry, 10 cr.
102 - General Chemistry: modern fundamental principles of chemistry with emphasis on non-metals; prereq: chem placement score 30 & math placement 30 [3 lc, 1 ds, 2 la; 5 cr]
104 - General Chemistry and Qualitative Analysis: prereq: C or better in Chem 102 [3 lc, 1 ds, 3 la; 5 cr]

Organic Chemistry, 8 cr.
343 - Organic Chemistry: prereq: C or better in Chem 104 [3 cr]
344 - Organic Chemistry Lab: prereq: C or better in Chem 343; coreq: Chem 345 [6 la; 2 cr]
345 - Organic Chemistry: prereq: C or better in Chem 343; coreq: Chem 344 [3 cr]

Quantitative Analysis, 4 cr.
223 - Elementary Quantitative Analysis: prereq: C or better in Chem 104; course equivalent to CompSci 132 [2 lc, 6 la; 4 cr]

Physical Chemistry, 3 cr.
560 - Introductory Physical Chemistry: prereq: jr st; C or better in Chem 104; Math 211; 2 sem physics; coreq: Math 405 [3 cr]

Biochemistry, 11 cr.
501 - Introduction to Biochemistry: chemistry of biological systems; prereq: jr st; C or better in Chem 223 & Chem 545 [3 cr]
601 - Biochemistry: Protein Structure and Function: cellular synthesis of proteins, protein structure/function, enzyme mechanisms; prereq: jr st; C or better in Chem 345 & Chem 560 or Chem 562. [3 cr]
602 - Biochemistry: Cellular Processes: biosynthesis and metabolism of nucleic acids, structure and replication of DNA, control of gene expression, signal transduction; prereq: jr st; C or better in Chem 501 or 601 [3 cr]
603 - Introduction to Biochemistry Laboratory: experiments in biological preparations, cloning techniques, protein chromatography, and enzyme characterization; prereq: jr st; C or better in Chem 501, 601, or 602; C or better in Chem 223 [2 cr]
604 - Biochemistry: Metabolism: glycolysis, photosynthesis, biosynthesis, metabolism; prereq: jr st; C or better in Chem 501 or 601 or cons. instr. [3 cr]

Research, 2 cr. min.
399 - Special Chemical Problems: prereq: cons instr.

Biology, 14 cr. (BioSci 150, 260, plus minimum 7 cr from approved list)
150 - Foundations of Biological Sciences I: intro to cellular and animal biology; prereq: chem placement score 30 [3 lc, 3 le; 4 cr]
260 - Genetics: principles of inheritance of living organisms; prereq: C or better in Chem 104 and Bio 150 [5 lc/ds; 3 cr]
303 - General Microbiology: study of the nature and properties of microorganisms; molecular biology and genetics of bacteria and viruses; surveys major groups; ecological relationships; taxonomy; prereq: jr st; Chem 341; Bio 260 [3 lc, 4 la; 4 cr]
401 - Immunology: prereq: jr st; Chem 341; Bio 260 [2 lc; 2 cr]
402 - Immunology Lab: coreq: Bio 401 [6 la; 2 cr]
405 - General Virology: prereq: Bio 303 or 470; Chem 501 [3 cr]
470 - Cell and Molecular Biology: prereq: Bio 150, 152, & 260; Chem 343 [3 lc, 4 la; 4 cr]
536 - Applied Microbiology and Biotechnology: prereq: Bio 303 [2 lc; 2 cr]
563 - Molecular Techniques for Evolution and Ecology: prereq: Bio 260; Chem 343 [3 cr]
607 - Aquatic Microbiology: prereq: Bio 303 & 514 [2 cr]
620 - Microbial Physiology: prereq: Bio 303 & Chem 501 [2 lc, 6 la; 4 cr]
630 - Endocrinology: prereq: Bio 150 & 152; Chem 343 [3 cr]
650 - Molecular Biology of Microorganisms: prereq: Bio 303 [2 lc, 1 ds; 3 cr]
660 - Eukaryotic Molecular Biology: prereq: Bio 303 [3 cr]
663 - Lab Techniques in Molecular Biology: prereq: Bio 303 & 260; Bio 470, 650 or 660 [2 lc/ds, 6 la; 4 cr]
667 - Advanced Techniques in Microbial, Molecular and Cellular Biology: special topics; prereq: sr st; Bio 303 [1 ds, 6 la; 3 cr]
676 - Cellular Evolution: prereq: sr st; Bio 260; Chem 344 & 345; Bio 303 or 470 or 660 or Chem 501 or 601 [3 cr]

Physics, 10 cr.
120 - General Physics I (non-calculus): mechanics, wave motion, heat and sound; prereq: math placement C [3 lc, 2 ds; 4 cr]
121 - General Physics Lab I: coreq: Phys 120 [1 cr]
122 - General Physics II (non-calculus): electricity, optics, modern physics; prereq: Phys 120 [3 lc, 2 ds; 4 cr]
123 - General Physics Lab II: coreq: Phys 122 [1 cr]

Mathematics, 10 cr.
205 - Introductory Finite Math: elements of math logic, sets, partitions and counting, probability theory, stochastic processes; prereq: math placement B, AB, or A [3 cr]
405 - Mathematical Models and Applications: construction and math models with applications to social sciences and life sciences, markov chains, linear programming, game theory, graph theory, growth processes; prereq: jr st; Math 205 and 211, or Math 234 [3 cr].

Model Four-Year Program
(numbers in parentheses = numbers of credits)

Year I
Chem 102 (5)  
Math 205 (3)  
Bio 150 (4)  
Freshman Seminar (3)

Year II
Chem 343 (3)  
Chem 223 (4)  
Phys 120, 121 (5)  
Elective (3)  
Chem 399 (2) (research)

Year III
Chem 560 (3)  
Chem 501 (3)  
Bio xxx (4)  
Elective (3)

Year III semester II & Year IV
2 of Chem 601 (3), Chem 602 (3), Chem 604 (3)
Chem 603 (2)
Chem 599 (2) (research)
Bio xxx (3)
Elective (X)
Elective (X)

Math/Science Credit Totals
Chemistry: 27, Biochemistry: 13, Biological Science: 14, Math: 10, Physics: 10,
Total: 74 of 120 for graduation
4.3 Interrelationship with Other Curricula: Primary curriculum support for this degree is based in the Department of Biological Sciences. The biology faculty members who teach the courses outlined in section 4.2 are listed in section 5.1. The biochemistry major is expected to compliment the proposed biotechnology certificate currently offered in the Biology Department. Since the two programs have overlap, it is altogether feasible for students to obtain both qualifications with the major demonstrating emphasis and comprehension of the subject matter and the biotechnology certificate verifying proficiency in a variety of laboratory techniques.

4.4 Method of Assessment or Evaluation: Conducting exit interviews for graduating students is one of the best methods for assessing the success of the curriculum. Students will be asked to fill out a brief questionnaire and express their opinion as to the value of the major. At this time addresses and methods of contact will be obtained so that future tracking of the careers of graduates will be possible as a method of assessing the value of the program to the students.

4.5 Accreditation Requirement: Neither The Federation of American Societies for Experimental Biology (FASEB) or The American Society of Biochemistry and Molecular Biology (ASBMB) offer curricular accreditation for biochemistry majors at this time. However, the proposed biochemistry major closely follows the guidelines of these organizations as to the content of the curriculum.

4.6 Strengths or Unique Features: Typically students who undertake biochemistry majors in other institutions do not have the option to take courses in biochemistry until their senior year. One of the unique features of the proposed major is the opportunity for students to enroll in biochemistry courses early in the degree program (see curriculum above). This allows the major to encompass a greater number of biochemistry courses, and it provides a pedagogical advantage in that it allows greater opportunity for the reinforcement of foundation concepts in addition to allowing a greater range of topics to be presented.

The math requirements of the major also are unique. The required math courses are a departure from the traditional calculus series (though students with the traditional calculus series are not excluded from the major). The math instead emphasizes models and applications (405) and has a calculus survey course (211) to introduce fundamental calculus concepts that are routinely applied in biochemical investigation. Because this emphasis directs students to focus on the application of math to real world problems, it is expected to be of greater value to the graduate who engages in biochemical research in both academic and industrial settings.

The research requirement is another strength of the program. Students need an understanding of the nature and difficulty of basic research to appreciate fully the expectations of their future employers. This requirement will be a distinct advantage to graduates as it will give them access to equipment, facilities, and techniques generally not employed in basic laboratory classes. Moreover the influx of undergraduates into the research laboratories will strengthen departmental research objectives.

4.7 Career Advising: Each student undertaking a major in the Chemistry Department at UW-Milwaukee is assigned a faculty advisor. The advisor assists students enrolled in this program
with the development of career goals. In particular, close contact with the student's advisor in the
design and execution of the research component of the degree will provide a valuable forum for
career planning advice.

4.8 Outreach: Students in the Chemistry Department have a number of opportunities to interact
with the community. The department currently presents demonstrations at local schools upon
request, participates in The National Chemistry Week proceedings, engages students in activities
through Student Affiliates of The American Chemistry Society, and is represented at the annual
UW-Milwaukee open house. Students are encouraged to participate in each of these functions to
help relate the seemingly esoteric nature of chemistry to the community and to encourage future
enrollment.

5. PERSONNEL

5.1 Chemistry Faculty Members Participating Directly in the Program:
David Petering; Professor (Inorganic Biochemistry)
Kristene Surerus; Associate Professor (Bioinorganic Spectroscopy)
Michael Reddy; Associate Professor (Viral Enzymology)
Graham Moran; Assistant Professor (Bioinorganic Enzymology)

5.2 Biology Faculty Members Teaching Upper-Level Courses in the Program:
Gerald Bergstrom; Professor (Cell and Molecular Biology)
John D Buntin; Professor (Behavioral Neuroendocrinology)
Mary Lynne Perille Collins; Professor (Microbial Physiology)
Steven Forst; Associate Professor (Molecular Microbiology)
Mark McBride; Associate Professor (Microbiology and Molecular Biology)
Daad A Saffarini; Assistant Professor (Environmental and Molecular Microbiology)
Cynthia Sommer; Associate Professor (Comparative Immunology)
Peter Wejksnora; Associate Professor (Eukaryotic Molecular Biology)
Charles Wimpee; Associate Professor (Molecular Evolution)

5.3 Advisory Faculty:
Benjamin Feinberg; Professor (Bio-Analytical Chemistry)
Andy Pacheco; Assistant Professor (Bioinorganic Chemistry)

5.4 Additional Faculty Requirements: None

5.5 Academic Staff: None

5.6 Classified Staff: None

6. ACADEMIC SUPPORT SERVICES
6.1 Library Resources: The existing facilities of the Golda-Meir Library are largely adequate for the proposed major. The selection of biochemical journals and monographs is sufficient for most biochemical topics to be researched thoroughly. The online services provided by the library are considerable; students who opt for this major will have access to biochemical literature search databases as well as online subscriptions to a number of biochemical journals, including the ACS publications. It is expected that copies of recent edition general biochemistry texts will be needed as a resource for students.

6.2 Additional Support Resources: Since the proposed biochemistry major does not involve the inception of new courses or staff hires, no additional resources are needed to launch the program. The Chemistry Department currently has a computer laboratory equipped with 40 IBM compatible and 6 Macintosh computers as well as a modest library housing chemical and biochemical journals and a number of texts. Students have access to photocopiers for teaching and personal use.

7. FACILITIES - EQUIPMENT

7.1 Capital Resources: The Chemistry Department at UW-Milwaukee has an extensive array of research facilities and capital equipment that is available to students conducting research. Equipment is either readily available departmental equipment or available collaboratively from the laboratories of the department's faculty members. Equipment includes three nuclear magnetic resonance spectrometers, a variety of mass spectrometers, super- and ultra-speed centrifuges, walk-in cold rooms, UV-visible spectrophotometers, X-ray crystallography facilities, electron paramagnetic resonance spectrometer, circular dichroism spectrophotometer, Mössbauer spectrophotometers, stopped-flow spectrophotometer, a thermocycler, a laminar flow hood, atomic absorption spectrophotometers, incubators, shaking incubators, electrophoresis equipment, gas chromatographs, high performance liquid chromatographs, and liquid chromatographs.

7.2 Capital Budget Needs: None

8. FINANCE

8.1 Operating Budget Requirements: There are no additional funding requirements specific to the proposed biochemistry major because the major simply maps a new curriculum from existing courses and can be accommodated within the funds currently allocated to the Department of Chemistry. This is solely a consequence of the strength, in terms of faculty research, in biochemistry at UWM.

8.2 Operating Budget--S&E Requirements: No additional funds required.

8.3 Operating Budget Reallocation: No additional funds required.

8.4 Extramural Research Support: A five year history of the extramural support for the faculty directly involved in the proposed biochemistry major is shown below. Biochemistry remains as
one of the most highly funded branches of chemistry. The ongoing extramural funding contributes directly to the quality of the degree. Students enrolled in the major gain experience with state-of-the-art instruments and current techniques through the required research component of the major. In addition, the biochemistry faculty members have grants specifically directed toward teacher enhancement in health education.

David Petering
1. “Cadmium, Zinc, Metallothionein and Kidney Toxicity” National Institutes of Health 1995 $850,000
2. “Metal Complexes of Known Antitumor Agents” National Institutes of Health 1997 $320,000
3. “Cellular Requirements for Iron by Bleomycin and Adriamycin” American Cancer Society 1996 $248,000
4. “A 500 Mhz Spectrometer for Biological Application” National Science Foundation 1997 $245,000
5. “Cadmium, Zinc, Metallothionein and Kidney Toxicity” National Institutes of Health 2000 $1,400,000
6. “Teacher Enhancement for Environmental Health Education” National Institutes of Health 2000 $432,000
7. “Metal Complexes of Known Antitumor Agents” National Institutes of Health 2001 $475,000
8. “Marine and Freshwater Biomedical and Sciences Center” National Institutes of Health 2003 $1,200,000
9. “Acquisition of Inductively Coupled Plasma Mass Spectrometer for Biogeochemistry” National Science Foundation 2002 $333,000

Kristene Surerus
1. “Mössbauer Studies of Site-Substituted Ferredoxin” National Science Foundation 1996 $18,000
2. “NO and Aconitase: Mössbauer Spectroscopic Studies” National Institutes of Health 1998 $107,124

Michael Reddy
1. National Institutes of Health Area Award 2002 $145,000
2. Shaw Scientist Award, The Milwaukee Foundation 1999 $135,000
3. “Assembly of the Bacterophage T4 DNA Replication Sliding Clamp” National Science Foundation 2000 $370,000

Graham Moran
New Assistant Professor