Biochemistry Department
Graduate Student Handbook

University of Missouri-Columbia

Revised December 2008

Tiger stripe ice cream at CAFNR picnic

Water lilies in Stephens pond

Atrium of the Medical School

Table of Contents

Welcome to the Graduate Program of the Biochemistry Department at the University of Missouri-Columbia. You are one of a select group. Our entire department, faculty, staff and students, are ready to assist you through your graduate education to achieve your goal of becoming a professional scientist.

Our Graduate Program in Biochemistry emphasizes training in research and critical thinking. It is closely interwoven with the scholarly activities of the faculty. We study the biochemistry of life across the entire spectrum of living things, plants, animals and microorganisms. Our department has been a leader in interdisciplinary cooperation and collaboration throughout our University, and your graduate training will be strongly influenced by these interdisciplinary involvements.

The entire faculty is available for advice and consultation. Most academic questions and concerns should be posed first to the Graduate Education Committee, particularly the committee's Chair, Dr. Steve Van Doren (37A Schweitzer Addition). In addition, all members of the departmental faculty and staff are prepared to assist you or direct you to the appropriate individual. As Chair, I am available to discuss academic issues not resolved by other means. For issues of student and community life, your graduate student mentor is a good source of information, as is the very active Biochemistry Graduate Student Organization. Importantly, the department has an "Ombudsman", Dr. Linda Randall, who is available for confidential discussion with any member of the Department, faculty, staff or student about any difficult or uncomfortable situation. If you find yourself in such a situation, do not hesitate to have a confidential talk with Dr. Randall.

This graduate handbook contains a wealth of important and useful information. Get in the habit of referring to it as you progress in our graduate program. Good luck in this exciting and challenging stage of your life.

Gerald L. Hazelbauer
Professor and Chair

Ph.D. Degree

Prerequisites

- Biochemistry — At least one lecture course and one laboratory course, equivalent to Biochm 4270, 4272, and 4974.
- Biological Sciences — One semester (e.g. general or microbiology)
- Physics — One year, equivalent to Physics 1210 and 1220.
- Organic Chemistry — One year with laboratory, equivalent to Chemistry 2100, 2110, 2130
- Calculus — One year, equivalent to Math 1500H and 1700.

Highly recommended courses

- Genetics or Molecular Biology — One semester, equivalent to Biology 2200 or 4976
- Biochemistry — Second semester of a lecture course, equivalent to Biochm 4272
- Quantitative Analytical Chemistry — One semester, equivalent to Chemistry 3200.
- Physical Chemistry — One semester of a course with a calculus prerequisite, equivalent to Chemistry 3300.

A limited number of the courses listed above may be completed after acceptance as a graduate student. Any deficiencies must be completed in the first year of the graduate program. For example, students who have not completed a physical chemistry course will take Biochm 4300, Physical Biochemistry, during the fall semester of the first year.

Graduate Record Examination

The general examination is required, and an advanced test is recommended.

TOEFL Exam

Students whose first language is other than English must take the TOEFL exam and score at least 620 on the paper version, 260 on the computer version, or 90 on the new version of the exam.

Research Rotations

To acquaint students with research laboratory settings, all incoming students participate in three research rotations during the first academic year. The purposes of rotations for the student include learning about laboratories of potential thesis advisors and exploring new areas of science.

Each rotation should be conducted for approximately one-half semester or a period of at least eight weeks. Two rotations are performed in the first semester with the second rotation ending December 31. The third rotation will begin on January 1 or at a time shortly thereafter, agreed upon by both the rotation faculty mentor and the student. For each of these two semesters, the student should register for 2 hours of Biochm 8450 (non-thesis research). The laboratory for the first rotation is determined during orientation week by discussion between the student, faculty and the Director of Graduate Studies (DGS). Second and third rotations are made in the course of the first semester by discussions between the student and the faculty and must be approved by the DGS. The faculty in whose laboratory the rotations

are carried out will evaluate the student's performance and recommend letter grades for Biochm 8450. Faculty and students will provide the GEC with short written critiques of their rotation experiences by the end of each semester. Students should not register for more than 2 credits of Biochm 8450 in any one semester.

During a rotation, the student should perform as a full member of the rotation laboratory. The student should have a desk and laboratory bench and a defined project supervised and guided by a member of the laboratory. One-half of the student's time and effort should be directed toward the rotation project, the other half toward course work. This means a nominal 20 hours per week working in the laboratory, but since successful graduate students and successful scientists usually work much more than 40 hours a week, the time of actual effort is commonly greater. The rotation laboratory should serve as an academic home and the student should participate in all usual laboratory activities, particularly weekly group meetings. In most cases, the student will present a report on the research pursued to the host laboratory at the end of the rotation period.

Assessment of the student's performance is made through the assignment of grades (Biochm 8450 requires A, B, or C grading) solicited at the end of the semester. In addition, the student and the faculty mentors are asked for input to the GEC regarding their experiences at the time of the annual review in January. All members of the GEC are available for consultation should a difficult or awkward situation arise for either party.

Selection of Thesis Advisers

By the end of the third rotation students should identify a thesis advisor from the group of doctoral faculty having financial support for students. The choice of advisor is subject to final approval by that individual, the GEC and by the department chairman. The student will receive credit for the fourth hour of Biochm 8450 for the work performed with the thesis advisor during the second semester following rotation. An important early task for the student is to assemble a Doctoral Program Committee (DPC) in consultation with his/her thesis advisor. For students entering in the fall semester, this should be accomplished by the end of the second semester in order to comply with the Graduate School's deadlines for submission of D1 and D2 forms or M1 and M2 forms.

Coursework

Thesis Research (Biochm 9090)
Prior to successfully completing the Comprehensive Examination, nine credit hours per semester or four credit hours per summer are required to remain a full-time graduate student. If required classes do not total nine credit hours, Biochemistry 9090 should be used to reach the total. Following successful completion of both parts of the Comprehensive Exam, students should register for a minimum of two hours of thesis research (Biochemistry 9090) per semester (one in summer) to maintain "continuous enrollment." More than the minimum may be needed to obtain the 72 credit hours required by the Graduate School for completion of the Ph.D. You must be registered in every semester prior to and including the semester in which you defend your dissertation.

Required Courses

Ph.D. students are expected to complete during the first two semesters, with passing grades of B or A, Introductory Graduate Biochemistry I and II (Biochem 9001-2 / 8240 and 9001-1 / 8260), also known as Macromolecular Structure & Function and Systems Biochemistry, respectively. Receipt of a grade of C in either of these courses is unsatisfactory, and the student must retake the course(s). Both required courses must be completed with a grade of B or above in order to remain a Ph.D. student in good standing. A grade of F in either of these two required courses will result in dismissal from the graduate program in Biochemistry, for lack of making "satisfactory progress". A student who has been dismissed has the right to appeal the dismissal to the department and Graduate Faculty Senate. Details on procedures for appeal to the department and Graduate Faculty Senate can be found at: http://gradschool.missouri.edu/policies/progress/extension-appeal.php

Elective Coursework to Fulfill
A Ph.D. student must pass with grade of B or better two additional graduate science courses at the 8000 or 9000 level, each of three hours or more and approved the student's doctoral program committee. To satisfy the need for electives, students are encouraged and pre-approved to enroll in any of the following Biochemistry courses: Molecular Biology I / Biochm 9430, Molecular Biology II / Biochm 9432, Physical Biochemistry / Biochm 8430 and Enzymology/Metabolism / Biochm 8432.

Ethics Seminar
Ethical Conduct of Research offered by Biological Sciences (BioSci 8187, 1 h), currently directed by Dr. Kathy Newton, (or the equivalent offered in another department) will be required of all Biochemistry graduate students.

Seminar (Biochm 9087, 4 credits total)
Students should enroll in Biochm 9087 during their first semester. Biochemistry 9087 in the fall semester is designed to teach the fundamental techniques of oral presentation of scientific information, slide preparation, computer graphics, overhead preparation, etc. In addition, research compliance training will also be provided.

Students should complete three additional semesters of Biochemistry 9087 in winter semesters of years 3, 4, and 5. (A student may ask the DGS for permission to take 9087 in year 2). A student's first winter 9087 seminar is devoted to a presentation of the proposed dissertation research. The second seminar should provide an update of research progress or a review of major journal papers in the student's research area. The third and final Biochm 9087 should be a practice for the dissertation defense. The student's thesis committee (Doctoral Program Committee, DPC) is expected to attend these presentations at the specific invitation of the student. A meeting with the DPC can often be conveniently arranged after the seminar presentation and serve as the required annual meeting.

Department Seminars
Students are required to attend all departmental seminars.

Credit Hours
The Graduate School requires a minimum of 15 credit hours of course work at the 8000-level or higher (exclusive of research, problems and independent study experiences). The aforementioned core course work will fulfill 14 hours or more of this requirement and Biochm

9087, the remainder. The student and his/her advisor in consultation with the student's DPC may decide upon additional courses. A minimum of 72 semester hours beyond the baccalaureate degree is required for the Ph.D. Within any limits imposed by the Graduate School or DPC, additional classroom graduate credit hours will apply to the requirement of 72 credit hours.

Residency
At least two nine-hour or three six-hour semesters must be completed in an 18-month period at MU to satisfy the residency requirement. All courses taken to satisfy the residency requirement must be MU courses approved for graduate credit and approved by the student's DPC.

Minimum Enrollment and Continuous Registration
Graduate students must maintain full-time status until they have passed both portions of the Comprehensive Exam. Full-time status is achieved by enrolling for 9 hours in Fall and Winter semesters and 4 hours during Summer term; students typically enroll in Biochm 9090 Research in order to complete their required hours.

Completion of the Comprehensive Exam admits a student to candidacy for the Ph.D. After the Comprehensive Exam has been passed, students must maintain continuous enrollment by registering in Biochm 9090 for at least 2 credit hours in fall and winter semesters and l credit hour in the summer. However, in order to meet the requirement for 72 hours of post-baccalaureate credit required by the Graduate School, it is typical for students to continue to enroll for up to 9 hours of Biochm 9090 per term until they accumulate close to 72 hours. Students may enroll in other courses in addition to 9090 and reduce the total 9090 hours taken. Failure to enroll in any semester results in cancellation of candidacy.

Financial Support

All Ph.D. candidates are provided with a graduate research assistantship from departmental sources for a maximum of twelve months of study. (As the University fiscal status changes, the departmental support may also be altered.) Special University and extramural fellowships may be used to supplement or extend this award. Laboratory rotations and the majority of the course work should be completed while students are supported by departmental sources. After departmental support, students will be supported by research grants, fellowships or other sources available to their mentors.

Fee and Fee Remission Program

Non-resident tuition and the resident education fees are waived. Student Activities Fees are paid by the Department during the first 12 months and subsequently by the mentor's research monies.

Doctoral Program Committee

The DPC membership is selected by the student's advisor in consultation with the student and appointed by the Dean of the Graduate School by the end of the second semester. In cases where matching of student with advisor is delayed, the DPC should be selected before one year has elapsed following the student's matriculation. The DPC shall be composed of a minimum of four members of the MU graduate faculty. The DPC will include at least three

members from Biochemistry faculty and an outside member from a different MU program. At least two of the DPC members must be MU doctoral faculty. Additional committee members with specialized expertise who do not meet the criteria for the MU graduate faculty or doctoral faculty may serve on a doctoral committees as a fifth or sixth member, with special permission of the vice provost/dean of the Graduate School. This committee will be responsible for advising the student throughout graduate study, for conducting the Qualifying process, for evaluation of the written Comprehensive Examination, and for evaluation of the dissertation and the final defense.

Program Qualifier

The purpose of the qualifying procedure is to provide an opportunity for the Doctoral Program Committee to approve the planned program of study. As such, the qualifier is not an exam. Rather, the qualifying procedure is simply the first meeting between the graduate student and his/her Doctoral Program Committee. For those students who choose their Ph.D. mentor in mid-winter semester, this first meeting with their Doctoral Program Committee should occur as soon as possible after they have identified a mentor and by the end of the second semester in order to fulfill Graduate School requirements.

The purpose of this meeting is to introduce the scientific interests and goals of the student to the committee. As with all meetings between the student and the Doctoral Program Committee, the student should prepare a brief written document in advance of the meeting that summarizes the topics to be discussed. This document should be distributed to the committee members at least one week in advance of the meeting.

The written document describes the student's "program of study" and consists of two parts, the formal coursework to be taken by the student and the research project(s) to be undertaken by the student. The student should provide a list of graduate level coursework that has been completed, along with the grades received. The student should also provide a list of proposed courses and indicate how the formal course requirements of both the Department and the Graduate School will be met. The committee will review the completed and proposed coursework and, if necessary, suggest additional courses for the student consistent with the research interests of the student.

The second part of the document is a brief one- to three-page description of a likely Ph.D. research project. The student should be prepared to introduce this preliminary research proposal during the meeting. The committee will review the project and provide suggestions and advice on how to further define the goals and direction of the proposed research.

The outcome of this meeting should be reflected in completion of the D-1 and D-2 forms available on the Graduate School website:
http://gradschool.missouri.edu/policies/doctoral/requirements/

Teaching Experience

An important part of graduate education is learning to communicate effectively as a teacher.

One semester of teaching experience is a required component of both the M.S. and Ph.D. degrees. This requirement is typically performed in the second year of graduate study,

although the Director of Graduate Studies may change this time frame to accommodate special circumstances. This teaching experience usually involves assisting a faculty member in one of several courses, including Biochm 4974 / 7274 (laboratory course for majors), Biochm 4374 / 7374 (Mol. Biol. Laboratory), Biochm 4270 / 7270, Biochm 4272 / 7272, Biochm 1090, Biochm 2002, Biochm 3630, or Biochm 4376 / 7376 (Protein Computer Modeling). The Biochemistry Department also offers a Zahler Fellowship for those graduate students who are particularly interested in teaching as a career and wish to gain additional teaching experience.

Three hours of 8000-level graduate course credit will be earned for this semester-long teaching experience. The faculty director of the course will assign a letter grade (A, B, C or F). This grade will be based on a clear set of expectations for the student teacher and regular review of the student's performance by the faculty director. The graduate student is entitled to a mid-semester, preliminary grade report. Students must satisfy this teaching requirement with a grade of "B" or better to remain in good standing as a graduate student in Biochemistry.

The University provides training to help students prepare for teaching and to expand their oral proficiency. All students (international or native English speakers) must participate in Teaching Assistant (TA) orientation and training offered before the semester in order to fulfill the departmental teaching requirement.

Missouri requires that students whose first language is not English must demonstrate adequate oral proficiency before they can assist in teaching. Proficiency is demonstrated by passing the University oral proficiency examination, currently called the SPEAK test. A student must score 2 or better on the SPEAK test in order to qualify to serve as teaching assistant. *Failure to pass the oral proficiency examination by the end of the first year following matriculation may result in termination from the graduate program.* Students with poor oral proficiency, as evidenced by a score of '1' on the exam, may be required to enroll in a University English course.

Oral Comprehensive Examination

Students who have passed both Introductory Graduate Biochemistry I and II courses with grades of B or better and are in good standing academically (cumulative GPA of 3.0 or better) should take the Oral Comprehensive Exam in January of their second year. Students who have not passed these two required courses in their year must pass them with grade of B or better by the end of the second year. The Oral Comprehensive Exam may be taken at an alternative time, but no later than January of their third year. The student who fails must wait a minimum of 12 weeks for the second opportunity allowed to take the comprehensive. Failure to pass two comprehensive examinations automatically prevents Ph.D. candidacy. Failure to pass this exam by January of the third year will also result in dismissal from the Ph.D. program.

The Oral Comprehensive Exam will be based upon a set of twenty questions that may vary from year to year (attached below are the questions you will be expected to answer).

Purposes

1. To emphasize that all graduate students on their way to a PhD. should have of knowledge

and understanding of the core of information that is the foundation contemporary biochemistry.

2. To provide a specific mechanism by which the faculty can assess that knowledge and understanding.

Background

Students taking the exam in January should devote some time and energy in the proceeding fall term to consideration of the core of information and concepts that are the foundation of contemporary biochemistry. Through review and synthesis, that core should become a permanent store of information and ideas. A Ph.D. in biochemistry should have active knowledge of these core areas. This is the time for each student to insure the possession of that active knowledge.This review and synthesis should be only one aspect of the student's activities in that term. Besides formal course work the student should be intensively involved in research. Research activity is the most crucial factor in evaluating performance as a graduate student, so it should not be neglected in favor of review of core knowledge.

Scope

What is the core of information and concepts that a student is expected to have at their command? It is broadly defined by the subject matter contained in current textbooks (Voet , Voet, and Pratt; Stryer; etc.). The crucial items are generally those covered in core undergraduate and graduate courses in biochemistry. A biochemist should have some familiarity with all the major areas included in the texts and an active knowledge of the central subjects that are emphasized in a comprehensive introductory biochemistry course like our Biochemistry *4270-4272 (or 7270-7272)* and in our core graduate courses.

What level of active knowledge is expected? A good assay is the ability to provide a concise (10 minute) oral explanation of a given area or issue to someone who has the general background but may not have the specific knowledge. This requires not only knowledge of specific observations and facts but also the understanding of significance and implications that will allow distillation of the essence of a subject. This is what a good teacher does when considering the specific subject in a class lecture. A second-year graduate student ought to be able to do the same, beginning with the wider picture, emphasizing the fundamental principles and providing relevant and informative details.

There is no one correct way to do this, no one "right answer". The members of the examination committee are looking for evidence of knowledge and thoughtful understanding. Thus a good response is an individualized explanation, rather than rote presentation of someone else's distillation.

Format

1. Second year students should review and master the core material as part of their activities in the fall semester.

2. Twenty questions that define the breadth of the core will be provided no later than the beginning of the semester as a guide for study. The questions will be derived from ones suggested by faculty. We also welcome suggestions for or comments about questions from students.

3. The questions will come from four areas:

I. Proteins and enzymes
II. Metabolism
III. Nucleic acids and gene expression
IV. Supramolecular structure and cell biology

4. The core exam will be administered each January by a faculty committee. The composition of this committee will likely be changed annually and will consist of four faculty members representing the general areas of biophysics, molecular biology and biochemistry.

a. Each student will respond to three questions among the twenty listed, the first chosen by that individual and the following two by the committee. Each question will be allotted a maximum of 30 minutes, making the entire core knowledge examination approximately 1.5 hours long.

b. For each question, the student will be given 10 minutes in which to address the subject. During that 10 minutes, interruption by faculty will be only for clarification. Following that time there will be 15-20 minutes for questions from the faculty and responses from the student. The intent will be primarily diagnostic, to probe the breadth and depth of the student's mastery of core biochemistry. For this reason, although questioning will be based on the student's presentation, it may delve into related areas of core biochemistry.

c. In the course of questioning probing breadth and depth, it is likely that a student will be unable to answer some questions. This is not unexpected, and is not a significant fault if an appropriate level of basic knowledge and understanding of the area has been demonstrated.

d. Because this is an examination of core knowledge and understanding, no notes or other aids are permitted.

Evaluation

1. Immediately after the ~1.5 hour core examination, the examination committee will discuss the student's performance and reach a consensus that will be conveyed to the student orally and also summarized in writing for consideration by the Graduate Education Committee.

2. The student's demonstration of knowledge of core biochemistry will be judged:

a. Satisfactory

b. Unsatisfactory

3. Students whose performance on the oral comprehensive examination is judged unsatisfactory have the option to take the exam a second time. Graduate School regulations require a period of at least 12 weeks before this second examination. In general, if this option is chosen, the second exam will be scheduled soon after the end of the winter term in which the exam was originally given.

Written Comprehensive Exam

The Written Comprehensive Exam must be completed following a satisfactory performance of the Oral Comprehensive Exam. Students who have entered the program in the fall semester should plan on taking their Written Comprehensive Exam in their fourth semester. The Written Comprehensive Exam must be completed no later than five semesters following matriculation. Failure to complete the exam on time will result in a mandatory meeting of the student and advisor with the GEC and may result in the student's dismissal from the Ph.D. Program.

Students must submit a written proposal in the current format of an NIH postdoctoral fellowship grant proposal to their DPC and the Director of Graduate Studies (DGS) one week in advance of the exam. The format of an NIH postdoctoral fellowship is explained in the subsection on Format below. Sufficient information must be incorporated into the written proposal for the committee to make an evaluation of the proposed research plan. Although the advisor is expected to provide information and input into the student's research proposal, the student should write the proposal, develop the rationale for the design of experimental approaches, and be prepared to defend it independently. It should be kept in mind that the proposal does not represent a contract for research but is a description of a logical series of experiments designed to contribute to the body of scientific knowledge in a given discipline.

The voting members of the examination committee for the Written Comprehensive Exam will consist of the student's DPC (minus the advisor) with a member of the GEC serving as chair. While the advisor is encouraged to sit in on the examination, he/she will not participate in the exam and cannot interject opinions or explanations. The advisor may voice an opinion or explanation after the student has finished the exam (i.e., during the discussion period prior to the committee's vote).

For the comprehensive examination to be successfully completed, at least 3/4 of the examination committee must vote to pass the student. If failure is reported, the committee may recommend further work or remedial measures. If circumstances warrant, the student may be allowed to retake portions of the examination. The student who fails may not take a second examination for at least 12 weeks. Less than full committee approval may result in the student being dismissed or transferred to the M.S. program. In the latter event, readmission to the Ph.D. program requires the support and agreement of the GEC or the departmental chair.

Generally the written portion is the last part of the Comprehensive Examination. When both portions are successfully completed, form D-3
http://gradschool.missouri.edu/policies/doctoral/requirements/d3.pdf
should be filled out and forwarded to the Graduate School.

Format

The required format of the written comprehensive proposal is detailed in this excerpt from the current NIH PHS416-1 postdoctoral fellowship instructions. The Biochemistry Department at MU, however, has interests well beyond the public health mission of NIH.

Research Proposal Description: Project Summary

The *Project Summary* is meant to serve as a succinct and accurate description of the proposed work. State the application's broad, long-term objectives and specific aims, making reference to public benefits of the project. Describe concisely the research design and methods for achieving the stated goals. This section should be informative to other persons working in the same or related fields and insofar as possible understandable to a scientifically or technically literate reader. Avoid describing past accomplishments and the use of the first person.

*Following sections A through D are limited to **10 pages**.*

A. Specific Aims

List the broad, long-term objectives and the goal of the specific research proposed, e.g., to test a stated hypothesis, create a novel design, solve a specific problem, challenge an existing paradigm or clinical practice, address a critical barrier to progress in the field, or develop new technology.

B. Background and Significance

Briefly sketch the background leading to the present application, critically evaluate existing knowledge, and specifically identify the gaps that the project is intended to fill. State concisely the importance and public relevance, to health or agriculture for example, of the research described in this application by relating the specific aims to broad, long-term objectives.

C. Preliminary Studies

Use this section to provide a succinct account of preliminary studies, if any, that are pertinent to the proposal. When available, preliminary results can help your doctoral program committee to evaluate your preparedness and capability to conduct PhD research. It will also help demonstrate the utility of the proposed project as a training experience.

D. Research Design and Methods

Describe the research design conceptual framework, procedures, and analyses to be used to accomplish the specific aims of the project. Include how the data will be collected, analyzed, and interpreted. Describe any new methodology and its advantage over existing methodologies. Describe any novel concepts, approaches, tools, or technologies for the proposed studies. Discuss the potential difficulties and limitations of the proposed procedures and alternative approaches to achieve the aims. As part of this section, provide a tentative sequence or timetable for the project.

The following section does not contribute to the page limit.

Literature Cited

List all literature references. Each reference must include the title, names of all authors, book or journal, volume number, page numbers, and year of publication.

See example at: http://www.niaid.nih.gov/ncn/grants/app/app.pdf

The reference should be limited to relevant and current literature. While there is not a page limitation, it is important to be concise and to select only those literature references pertinent to the proposed research.

Evaluation of Written Comprehensive Proposal

For the preparation of the proposal, the students are encouraged to use the resources at hand

including faculty and other students. Advisors should use the preparation of this proposal as an opportunity to mentor the student in the science proposed and in the formulation of a proposal. Detailed editing and exact outlining of the experiments are the responsibility of the student. The student will be evaluated on 1) writing skills, 2) deductive thinking, 3) inductive thinking, 4) experimental design, and 5) knowledge of the pertinent literature, current and past.

The proposal should be clearly written and logically presented. However, the ideas incorporated should form the basis for additional questioning to determine whether the student can identify significant biochemical questions related to his/her work and devise a logical experimental plan to address the issues. An understanding of basic biochemical principles should be demonstrated.

Standards of Academic Performance

Doctoral students must maintain an acceptable level of academic performance in order to remain in the program. When a student receives two 'C's in graduate courses, or spends two consecutive semesters on academic probation, he/she will be notified in writing that his/her performance is not satisfactory. A student's DPC and advisor may also decide that a student's performance is not satisfactory. Unsatisfactory performance may result in dismissal from the PhD program. Students may elect to apply to the GEC to change to the M.S. program. Decisions regarding a student's standing in the Department are made by the GEC and can be appealed to the Department Chair, and then to the Graduate Faculty Senate Committee on Graduate Student Appeals.

Departmental Ombudsman

The position of "Ombudsman" originated in Scandinavian society. Note that in Swedish and other Scandinavian languages, the word "man" is without gender and equivalent to the English "one", as in "One should be diplomatic in these situations". In many Scandinavian organizations, whether political, commercial or academic, there is an ombudsman who serves as an unbiased and confidential listener, gives advice and can take action if an individual so desires. An ombudsman can provide receptive channel for discussing difficult and awkward situations, council in times of tension or conflict, and effective action to resolve potentially volatile situations.

In the Department of Biochemistry, Dr. Linda Randall serves as Departmental Ombudsman. As part of her departmental service activities, she is available for confidential consultation and advice to all departmental personnel, students, staff members and faculty members about situations related to the Department or departmental personnel. She has many years of experience in this role, and been of substantial help in a range of difficult situations. Dr. Randall will not discuss issues brought to her as Ombudsman with anyone else or take any action unless the concerned individual approves.

You should be aware that Dr. Randall has a particular empathy with students, because she continues to work intensively in the laboratory, doing experiments constantly. Thus she is fully aware of the challenges of day-to-day experimentation and of life in a laboratory. For this reason, you should not hesitate to talk with her if you find yourself in need of a sympathetic ear and of unbiased and knowledgeable advice.

Dissertation Defense

Upon completion of dissertation research, and with the approval of his/her advisor, the student will prepare a thesis. He/she should adhere to the Graduate School Guidelines for thesis preparation (http://web.missouri.edu/~gradschl/downloads/downloads.htm). Submission of the thesis to the Graduate School will be electronic. Thesis defense involves a public research seminar followed by a closed meeting of the candidate with his/her DPC. Upon examination of the thesis and thesis research, the committee will vote to accept or reject the thesis.

Dissertation Preparation and Submission

The GEC of the Biochemistry Department recommends the following guidelines for preparation of dissertations and thesis:

- The standard requirements of the Graduate School at the website:
  http://gradschool.missouri.edu/policies/doctoral/
- The Style Manual published by the Council of Biology Editors, Inc.

for questions of punctuation, capitalization, and other matters of general style.

- The format of the *Journal of Biological Chemistry* (or the premier journal in the discipline of the research) for references with the full title and inclusive page numbers of the articles.
- All other matters of style to be at the discretion of the dissertation director.

These guidelines are intended to allow flexibility so that the dissertation research can be readily assimilated into publishable form. *An electronic and bound copy of the dissertation must be submitted to the Department.*

Forms

The student is responsible for acquiring and filing the proper forms for submission to the Graduate School during the course of the program. These forms (D1 through D4) are available from the Graduate School, 210 Jesse Hall, and on the Graduate School website: http://gradschool.missouri.edu/policies/doctoral/requirements/

Timetable for students pursuing a Ph.D. starting Fall 2008:

Date / Semester	Courses [#]	Forms
Fall 2008	***Graduate Biochemistry I 9001-2/ 8240 (4h) – Macromolecular Structure & Function** ***Seminar 9087 (1h)** ***Research Rotations 8450 (2h) – Lab Rotations #1 & #2** **If no previous P-chem , then Physical Biochemistry 4300** **Option: 8000-level elective such as Enzymology & Metabolism (Bchm 8432)**	
Dec. 2008	**Submit annual report at:** https://gradschool.missouri.edu/policies/progress/annual-review/progress-system/index.php	
Jan. 2009	**MEET WITH GEC! – Thurs., Jan. 8 or Fri., Jan. 9**	
Winter 2009	***Graduate Biochemistry II 9001-1/ 8260 (4h) -- Systems Biochemistry** **Option: Physical Biochemistry (8430) or Molecular Biology II (9432) (with permission of instructor) or approved 8000-level science elective** ***Research Rotation 8450 (1h) -- Rotation #3** **Choose adviser by March 15** **SPEAK English test for internationals who are not native English speakers**	
	Select DPC by April 7	**D-1**
	Program Qualifier by May 7	**D-2**
May–June '09	**Oral Comprehensive 20 Question Exam**	
Summer 2009	***Thesis Research (9090 ; 4h)**	
August 2009	*** T.A. Training (for teaching in F07/W08)**	
Fall 2009	**8000+-level elective in biochemistry / approved science, e.g. Enzymology & Metabolism (8432) or Molecular Biology l (9430)** **Potential teaching experience (Bchm 9001D) Fall 2009 or Winter 2010[+]**	
Dec. 2009	**Submit annual report at:** https://gradschool.missouri.edu/policies/progress/annual-review/progress-system/index.php	
January 2010	**MEET WITH GEC!** **Possible time for second chance to take Oral Comprehensive 20 Question Exam**	
Winter 2010	***Ethical Conduct of Research (Bio Sci 8187, 1h)** **Potential teaching experience (Bchm 9001D) Fall 2009 or Winter 2010[+]** **8000-level biochemistry or science elective such as Molecular Biology II (9432)** **Written Comprehensive Exam completed by April 30, 2010**	**D-3**
Summer 2010	***Thesis Research (9090 ; 4h if haven't passed Comps or ≥ 1h if passed Comps)**	
Fall 2010	***Thesis Research (9090; to reach 2h if passed Comps or 9h if didn't pass Comps)**	
Fall or Winter 2011, '12, '13	**Seminar 9087 (1h)**	
Annual meeting required with Doctoral Program Committee by May 10, 2010, '11, '12 at Winter semester end, submit annual report at: https://gradschool.missouri.edu/policies/progress/annual-review/progress-system/index.php		
	DEFENSE!	**D-4**

***Required courses**

[#] **Bchm 9090 research credit hours are added each term to reach the expected number of credit hours**

[+] **Only one teaching experience is required**

M.S. Degree

Coursework

Required Courses- Both of the following two is required, with a passing grade of B or better:

– Intro to Graduate Biochemistry I: Macromolecular Structure & Function (4h)
– Intro to Graduate Biochemistry II: Systems Biochemistry (4h)

Seminar (Biochemistry 9087) (2h)

Research (Biochemistry 8090) (4h)

Ethical Conduct of Research – (Bio Sci 8187) (1h)

Elective 1: 8000-level Biochemistry or science approved by graduate program committee such as:

Biochemistry 9430 (4h) - Molecular Biology I
Biochemistry 9432 (4h) - Molecular Biology II
Biochemistry 8430 (3h) - Physical Biochemistry
Biochemistry 8432 (3h) - Enzymology and Metabolic Regulation

Elective 2: Outside graduate level course or science approved by graduate program committee such as Biochemistry 9430 or 9432

Departmental Seminars - All students are required to attend departmental seminars.

Required Courses

M.S. students are expected to complete during the first two semesters, with passing grades of B or A, Introductory Graduate Biochemistry I and II (Biochem 9001-2 / 8240 and 9001-1 / 8260), also known as Macromolecular Structure & Function and Systems Biochemistry, respectively. Receipt of a grade of C in either of these courses is unsatisfactory, and the student must retake the course(s). Both required courses must be completed with a grade of B or above in order to remain an M.S. student in good standing. A grade of F in either of these two required courses will result in dismissal from the graduate program in Biochemistry, for lack of making "satisfactory progress". A student who has been dismissed has the right to appeal the dismissal to the department and Graduate Faculty Senate. Details on procedures for appeal to the department and Graduate Faculty Senate can be found at: http://gradschool.missouri.edu/policies/progress/extension-appeal.php

Ethics Seminar

Ethical Conduct of Research offered by Biological Sciences (BioSci 8187, 1 h), currently directed by Dr. Kathy Newton, (or the equivalent offered in another department) will be required of all Biochemistry graduate students.

Residency

Thirty hours of advanced study (7000 to 9000 level) are required. However, within the Department only 8000/9000 level courses count as advanced study. Fifteen of the thirty hours must be at the 8000 to 9000 level. Special research problems (Biochemistry 7085), Non-thesis Research 8450 and Thesis Research 8090 or 9090 can contribute only twelve hours to this total. There is, therefore, an actual formal coursework requirement of eighteen hours. Twenty-four of the 30 h must be completed at MU. Continuous enrollment is not required, but access to University facilities does necessitate enrollment. Students must be

enrolled in the semester of the thesis defense but can register for "examination only" status.

Financial support

Students may be supported by grant funds and extramural support. Departmental support is rare. Master's students may apply for departmental stipends by filing a written request in conjunction with his/her advisor. A recommendation will be made by the GEC to the departmental chair who will make the final decision. Support normally ceases 24 months after matriculation unless continuation is approved by departmental chair or the advisor (in the case of grant support).

Fees and Fee Remission

Non-resident tuition and the resident educational fee are waived for those students receiving at least partial (25%) support from any faculty or departmental sources. Incidental Student Fees (computer, activity, etc.) will be paid by a research advisor through a non-grant source of funds where possible.

Teaching Experience

An important part of graduate education is learning to communicate effectively as a teacher.

One semester of teaching experience is a required component of both the M.S. and Ph.D. degrees. This requirement is typically performed in the second year of graduate study, although the Director of Graduate Studies may change this time frame to accommodate special circumstances. This teaching experience usually involves assisting a faculty member in one of several courses, including Biochm 4974 / 7274 (laboratory course for majors), Biochm 4374 / 7374 (Mol. Biol. Laboratory), Biochm 4270 / 7270, Biochm 4272 / 7272, Biochm 1090, Biochm 2002, Biochm 3630, or Biochm 4376 / 7376 (Protein Computer Modeling). The Biochemistry Department also offers a Zahler Fellowship for those graduate students who are particularly interested in teaching as a career and wish to gain additional teaching experience.

Three hours of 8000-level graduate course credit will be earned for this semester-long teaching experience. The faculty director of the course will assign a letter grade (A, B, C or F). This grade will be based on a clear set of expectations for the student teacher and regular review of the student's performance by the faculty director. The graduate student is entitled to a mid-semester, preliminary grade report. Students must satisfy this teaching requirement with a grade of "B" or better to remain in good standing as a graduate student in Biochemistry.

The University provides training to help students prepare for teaching and to expand their oral proficiency. All students (international or native English speakers) must participate in Teaching Assistant (TA) orientation and training offered before the semester in order to fulfill the departmental teaching requirement.

Missouri requires that students whose first language is not English must demonstrate adequate oral proficiency before they can assist in teaching. Proficiency is demonstrated by passing the University oral proficiency examination, currently called the SPEAK test. A student must score 2 or better on the SPEAK test in order to qualify to serve as teaching

assistant. *Failure to pass the oral proficiency examination by the end of the first year following matriculation may result in termination from the graduate program.* Students with poor oral proficiency, as evidenced by a score of '1' on the exam, may be required to enroll in a University English course.

Standards of Academic Performance

MS students must maintain an acceptable level of academic performance in order to remain in the program. A student who has spent two consecutive semesters on academic probation will be notified in writing that his/her performance is not satisfactory. A student's thesis committee and advisor may also decide that a student's performance is not satisfactory. Unsatisfactory performance may result in dismissal from the MS program. Decisions regarding a student's standing in the Department are made by the GEC, and can be appealed to the Department Chair, and then to the Graduate Faculty Senate Committee on Graduate Student Appeals.

Thesis Defense

The candidate will defend his/her thesis research at the end of the second year. This involves a public research seminar followed by a closed meeting of the candidate with his/her thesis committee. Upon successful defense the committee will certify that the thesis is worthy of acceptance.

Thesis Committee Composition

Adviser
A second Biochemistry faculty member
A faculty member from outside the Biochemistry Department
The committee is assembled within the first year in consultation with and the approval of the research advisor.

Thesis Preparation and Submission

The Graduate Committee on the Biochemistry Department recommends the following guidelines for preparation of dissertations and theses:

- The Guidelines of the Graduate School at:
  http://gradschool.missouri.edu/policies/masters/
- The Style Manual published by the council of Biology Editors, Inc., for questions of punctuation, capitalization, and other matters of general style;
- The format of the Journal of Biological Chemistry (or the premier journal in the discipline of the research) for references with the full title and inclusive page numbers of the articles; and
- All other matters of style to be at the discretion of the Thesis Director.

These guidelines are intended to allow flexibility so that the dissertation research can be readily assimilated into publishable forms. Submission to the Graduate School is electronic. *An electronic copy of the thesis must be submitted to the department.*

Forms

The student is responsible for obtaining the proper forms from the Graduate School, 210

Jesse Hall, or from the Graduate School website:
http://gradschool.missouri.edu/policies/masters/requirements/
All candidates must be enrolled on the University of Missouri, Columbia Campus during the semester in which completion of the final oral defense is approved.

Appendix A
Department of Biochemistry
University of Missouri

ACADEMIC AND PROFESSIONAL HONESTY

The University of Missouri Graduate School states:

"ACADEMIC HONESTY AND PROFESSIONAL ETHICS

Academic honesty is essential to the intellectual life of the University. Students who use, or attempt to use as their own the answers, words, ideas or research findings of another person are guilty of academic dishonesty. In addition to such acts of cheating or plagiarism, any unauthorized possession of examinations, hiding of source materials, or tampering with grade records are acts of academic dishonesty specifically forbidden by University rules.

According to the MU Faculty Handbook, faculty are required to report to their departmental chair and the provost's office all acts of academic dishonesty committed by graduate and undergraduate students. In all such cases, the faculty member should discuss the matter with the student and then make an academic judgment about the student's grade on the work affected by the dishonesty and, where appropriate, the grade for the affected course. The decision as to whether disciplinary proceedings are instituted is made by the provost. Because of the importance of honesty to academic and professional life, acts of dishonesty by graduate students may result in suspension or dismissal from the University.

Graduate students also should be aware that most professional associations have codes of ethics. These codes vary considerably across fields, but tend to provide guidelines for a broad array of professional responsibilities including teaching, research and working with clients. Violations of a code of ethics can lead to negative sanctions by one's professional colleagues and the expulsion from the professional associations in one's field. Graduate students are encouraged to obtain copies of codes of ethics for their chosen profession from the director of graduate studies in their department or program."

A graduate student must maintain high standards of academic honesty throughout his graduate career, fully in class, teaching and research settings. Finding of academic dishonesty can result in a failing grade in a course and severe academic restrictions that can include probation, loss of PhD candidacy and immediate dismissal of the student from the graduate program.

An example of professional ethical standards required of scientific authors by a major commercial publishing house follows. Elsevier requires authors of papers in its journals to certify that the papers adhere to these standards:

- "be the authors' own original work, which has not been previously published elsewhere
- reflect the authors' own research and analysis and do so in a truthful and complete manner,
- properly credit the meaningful contributions of co-authors and co-researchers,
- be appropriately placed in the context of prior and existing research. "

The Biochemistry faculty endorse the principles of Academic and Professional Honesty above and expect graduate students to abide by them.

Appendix B
Department of Biochemistry
University of Missouri

FACULTY 2006

CORE FACULTY
(*Doctoral Faculty)

***BEAMER, LESA,** Associate Professor. Ph.D. 1991, Johns Hopkins School of Medicine. Protein crystallography. (573) 882-6072. 105A Schlundt Annex.

***DEUTSCHER, SUSAN L.**, Associate Professor. Ph.D. 1985, St. Louis University Medical School. Combinatorial approaches to cancer therapies; antibody-nucleic acid interactions and their role in autoimmune disease. (573) 882-2454. 702A Medical Sciences Building.

***EMERICH, DAVID W.,** Professor, Associate Chair and Director of Undergraduate Education. Ph.D. 1977, University of Wisconsin. Enzymology and physiology of biological nitrogen fixation and related metabolic activities in bacteria and plants. (573) 882-4252. 226 Schweitzer Hall.

***FOLK, WILLIAM R.**, Professor. Ph.D. 1970, Stanford University. Gene expression and DNA replication in eukaryotes and DNA tumor viruses; Expression of tRNAs in plants. (573) 882-4857. 202 Schlundt Annex.

***GUILFOYLE, THOMAS**, Professor. Ph.D. 1974, University of Illinois. Auxin control of plant transcription. Plant RNA polymerases. (573) 882-7648. 10 Schweitzer Hall.

***HANNINK, MARK**, Professor. Ph.D. 1987, University of California, San Diego. Biological and biochemical functions of cellular oncogenes, with emphasis on c-*rel*. (573) 882-7971.
440E Bond Life Sciences Center.

***HAZELBAUER, GERALD,** Professor and Chair. Ph.D. 1971, University of Wisconsin. Transmembrane receptors and sensory transduction; bacterial chemotaxis. (573) 882-4845. 117 Schweitzer Hall.

***HENZL, MICHAEL,** Associate Professor. Ph.D. 1980, University of Wisconsin. Structure and function of calcium-binding proteins. Physiological function of the parvalbumins. (573) 882-7485. 11C Schlundt Annex.

***LUBAHN, DENNIS B.**, Professor. Ph.D. 1983, Duke University. Biochemical genetics of the estrogen receptor. (573) 884-6781. 110A Animal Science Research Center.

***MARTIN, MARK E.**, Associate Professor. Ph.D. 1985, University of Mississippi Medical Center. Eukaryotic gene expression; polyomavirus gene expression. (573) 882-5654. M701 Medical Sciences Building.

***MAWHINNEY, THOMAS P.**, Associate Professor. Director of College of Agriculture Experiment Station Laboratories, Ph.D. 1977, Albany Medical College. Analysis of exocrine secretions; development of analytical methodologies.
(573) 882-3848. 4 Agri. Bldg..

***MCCLURE, BRUCE A.**, Professor. Ph.D. 1987, University of Minnesota. Gametophytic self-incompatibility systems in plants. Biochemistry of gene expression in plants. (573) 882-3932. 240A Bond Life Sciences Center.

***PECK, SCOTT**, Associate Professor. Ph.D. 1995, Michigan State University. Proteomics. (573)882-8102. 271H Bond Life Sciences Center.

***PECULIS, BRENDA A.,** Associate Professor, Ph.D. 1991, Johns Hopkins University. snoRNPs and proteins involved in pre-rRNA processing; RNA:RNA and RNA:protein interactions in ribosome biogenesis. (573) 884-1424. 11B Schlundt Annex.

***PETRIS, MICHAEL,** Associate Professor Nutritional Sciences, Director of Graduate Recruitment and Admissions. Ph.D. 1998, University of Melbourne, Australia. Regulation of copper transport and copper-transporting P-type ATPases in eukaryotes and prokaryotes. (573) 882-9685. 540D Bond Life Sciences Center.

***PHILLIPS, CHARLOTTE**, Associate Professor. Ph.D. 1987, North Carolina State University, Raleigh, NC. Biochemistry and genetics of collagen metabolism. (573) 882-5122. M718 Med Sci Bldg.

***POLACCO, JOSEPH C.**, Professor. Ph.D. 1971, Duke University. Plant cell genetics; assimilation of fixed nitrogen by legumes. (573) 882-4789. 112 Schweitzer Hall.

***QUINN, THOMAS P.**, Professor. Ph.D. 1988, St. Louis University Medical School. Radiopharmaceutical design; protein molecular modeling and molecular graphics. (573) 882-6099. 103A Schlundt Annex.

***RANDALL, LINDA,** Professor. Ph.D. 1971, University of Wisconsin. Molecular chaperones in protein export and analysis of protein-protein interactions. (573) 884-4160. Stephens Hall.

***ROGERS, ELIZABETH**, Assistant Professor. Ph.D. 1997, Harvard University. Regulation and molecular mechanisms of iron uptake and translocation in plants. (573) 882-9830. 371D Bond Life Sciences Center.

***SCHMIDT, FRANCIS J.**, Professor. Ph.D. 1973, University of Wisconsin. Nucleic acid biochemistry; RNA processing; bacterial antibiotic resistance. (573) 882-5668. M706 Medical Sciences Building.

SIEGEL, MARCELLE, Assistant Professor. Ph.D. 1999, University of California at Berkeley. Science Education. (573) 882-9248. 124 Schweitzer Hall.

***SUN, GRACE**, Professor. Ph.D. 1966, Oregon State University. Receptor-mediated signal transduction pathways in cerebral ischemia; molecular mechanism of alcoholism. (573) 882-5377. M710 Medical Sciences Building.

***THELEN, JAY**, Assistant Professor. Ph.D. 1998, University of Missouri-Columbia. Proteomics of seed development and plastid differentiation. (573) 884-1325. 271G Bond Life Sciences Center.

***TIPTON, PETER A.**, Professor. Ph.D. 1987, University of Wisconsin, Madison. Application of tools and methods of modern mechanistic enzymology to enzyme systems. (573) 882-7968. 204A Schlundt Annex.

***TSIKA, RICHARD,** Professor. Veterinary Biomedical Sciences, Ph.D. 1987, University of California-Irvine. Transcriptional regulation of muscle genes; Transcription factors involved in adult-stage muscle fiber-phenotype; transgenic analysis. (573) 884-4547. 440D Bond Life Sciences Center

***VAN DOREN, STEVEN**, Associate Professor. Director of Graduate Studies. Ph.D. 1991, University of Illinois at Urbana-Champaign. Multi-nuclear, multi-dimensional NMR determination of protein structure. (573) 882-5113. 11A

Schlundt Annex.

***WALL, JUDY D.**, Professor, Ph.D. 1973, Duke University. Genetics and biochemistry of sulfate-reducing bacteria. (573) 882-8726. 214 Schweitzer Hall.

***WEISMAN, GARY A.**, Professor. Ph.D. 1982, University of Nebraska. Cell biology and nutrition; biochemistry and physiology of purinoreceptors; cystic fibrosis. (573) 882-5005. 540E Bond Life Sciences Center

***ZHANG, SHUQUN,** Associate Professor. Ph.D. 1994, University of Texas, Austin. MAP kinases in plant defense responses. (573) 882-5837. 371G Bond Life Sciences Center.

JOINT FACULTY
(*Doctoral Faculty)

***BURKE, DONALD,** Associate Professor. Molecular Microbiology and Immunology. Ph.D. 1992, University of California-Berkeley. Biochemistry of ribozymes and RNA aptamers.
(573) 882-8989. 471H Bond Life Sciences Center.

***CHEN, SHI-JIE,** Associate Professor. Biological Physics, Ph.D. 1999, University of California, San Diego. Physico-chemical models and computational methods for molecular biology. (573) 882-6626. 302 Physics Building.

***GATES, KENT,** Professor of Chemistry. Ph.D. 1990, Northwestern University. Mechanisms of DNA damage by synthetic and naturally occurring antitumor agents, toxins, and mutagens. (573) 882-6763. 125 Chemistry Building.

***MIERNYK, JAN,** Research Molecular Biologist. USDA, Plant Genetic Research Unit USDA, Columbia, MO, Ph.D. 1980, Arizona State University. Protein targeting, co- and post-translational protein modification by phosphorylation, glycosylation, and acylation. (573) 882-8167. 108 Curtis Hall. [officially Adjunct, but operationally joint]

***RENEKER, LIXING W**., Associate Professor Ophthalmology. Ph.D. 1991, University of Iowa. Molecular mechanism of eye development and signal transduction in lens cells. (573) 884-0350. EC214 Mason Eye Institute.

***ROBERTS, R. MICHAEL**, Professor Animal Sciences. D.Phil. 1965, Oxford University, England. Establishment and maternal recognition of pregnancy. Function and hormonal control of synthesis of secretory glycoproteins by the uterus and the early conceptus. (573) 882-0908. 240B Bond Life Sciences Center.

***SHARMA, KRISHNA K.**, Professor Ophthalmology. Ph.D., 1983, University of Mysore, India. Structure-function of ocular proteases and peptide hydrolases; mechanism of cataract development. (573) 882-8478. EC 214 Mason Eye Institute.

***STACEY, GARY**, Professor Plant Pathology. Ph.D. 1981, University of Texas. Functional genomics of plant-microbe interactions and plant development. (573) 884-4752. 271E Bond Life Sciences Center.

***TANNER, JACK**, Associate Professor Chemistry. Ph.D. 1988, Brown University**,** Chemistry. Protein Crystallography. (573) 884-1280. 211 Chemistry.

***VOLKERT, WYNN A.**, Professor Radiology. Ph.D. 1968, University of Missouri. Radiopharmacy and nuclear medicine. (573) 443-2511, extension 6681. B06 VA Hospital.

PROFESSIONAL TRACK FACULTY

Instructional Track

FREYERMUTH, SHARI, Resident Instruction Assistant Professor. Ph.D. 1991, Duke University. Biochemistry education. (573) 882-7643. 107 Schweitzer Hall

PETERSON, VIRGINIA E., Resident Instruction Associate Professor. Ph.D. 1980, University of Maryland. Biochemistry education. (573) 882-4493. 118 Schweitzer Hall.

Research Track

ELIAS, DWAYNE, Research Assistant Professor. Ph.D. 2002, University of Oklahoma. Bioremediation of metal contamination. (573) 882.9771. 217 Schweitzer Hall.

ERB, LAURIE, Research Associate Professor, (Weisman Laboratory). Ph.D. 1993, University of Missouri. Molecular studies of nucleotide receptors. (573) 884-2065. 540F Bond Life Sciences Building.

GLINSKII, VLADISLAV V., Research Assistant Professor, (Quinn Laboratory). M.D. 1979, Chernovtsy State Medical Institute, Ukraine. Molecular mechanisms of cancer metastasis. A047 Veteran's Hospital, (573) 814-6000 ext. 3691.

HAGEN, GRETCHEN, Research Professor, (Guilfoyle Laboratory). Ph.D. 1978, University of Georgia. Control of gene expression by plant growth regulators. (573) 882-7300. 10 Schweitzer Hall.

HEESE, ANTJE, Research Assistant Professor. Ph.D. 1997, Michigan State University. Membrane trafficking and Avr9/Cf-9 mediated plasma membrane responses. (573)882-3831.
540G Bond Life Sciences Center.

MOONEY, BRIAN, Research Assistant Professor, Associate Director of Charles W. Gehrke Proteomics Center. Ph.D. 1996, University College Dublin, Ireland. Protein expression and assembly; Metabolic engineering. (573) 884-7374. 214 Bond Life Sciences Center.

MOSSINE, VALERI, Research Assistant Professor, (Mawhinney Laboratory). Ph.D. 1988, Institute of Physical chemistry, Acad. Sci. of Ukraine. Multivalent lactulose-amines as inhibitors of prostate cancer metastasis. (573) 882-2608. Room 4, Agriculture Building.

SEYE, CHEIKH, Research Assistant Professor, (Weisman Laboratory). Ph.D. 1997, University of Paris. Cardiovascular Disease. (573) 884-1331. 540C Bond Life Sciences Building.

SIMONYI, AGNES, Research Associate Professor. (Sun Laboratory). Ph.D. 1988, University of Lorand Eotvos Hungary. Neuroscience. (573) 884-6178. M314 Medical Sciences Building.

TIWARI, SHIV, Research Assistant Professor, (Guilfoyle Laboratory). PhD at Jawaharlal Nehru University, New Delhi, India. Molecular genetics and plant biochemistry. (573) 882-7300. 12 Schweitzer Hall.

Joint

FORRESTER, LAWRENCE JOE, Research Assistant Professor. Ph.D. 1981, University of Missouri. Associate Director of the Molecular Biology DNA Core Facility. (573) 882-0428. 216 Bond Life Sciences Bldg..

ZOU, XIAOQIN, Research Assistant Professor, Assistant Investigator Dalton Cardiovascular Research Center. Ph.D. 1995, University of California, San Francisco. Computational Biology. (573) 882-6045. 117A Dalton Building.

EMERITUS FACULTY

CAMPBELL, BENEDICT J., Professor Emeritus. Ph.D. 1957, Northwestern University. Medical Education. (573) 882-8797. M702 Medical Sciences Building.

FEATHER, MILTON S., Professor Emeritus. Ph.D. 1963, Purdue University. Scientific Editorial Services, 6 Sommerton Drive, Greensboro, NC 27408-3845.

GEHRKE, CHARLES, Professor Emeritus. Ph.D. 1947, Ohio State University. (573) 882-4845.

MORRIS, ROY O., Professor Emeritus. Ph.D. 1958, University College, London. (573) 882-4845.

MOSCATELLI, EZIO A., Professor Emeritus. Ph.D. 1958, University of Illinois. Medical Education. (573) 882-2927. M712 Medical Sciences Building.

O'DELL, BOYD L., Professor Emeritus. Ph.D. 1943, University of Missouri. Biochemical and physiological functions of trace elements: Metabolism and bioavailability of trace elements. (573) 882-5197. 220 Eckles Hall.

PICKETT, EDWARD E., Professor Emeritus. Ph.D. 1948, Ohio State University. (573) 882-5198. 8 Research Park.

RANDALL, DOUGLAS D., Professor Emeritus and Director of Interdisciplinary Program in Plant Biochemistry-Physiology. Ph.D. 1970, Michigan State. Plant metabolism, plant signal transduction, protein kinases and phosphorylated proteins. (573) 882-4847. 223 Schweitzer Hall.

WIXOM, ROBERT L., Professor Emeritus. Ph.D. 1952, University of Illinois. (573) 882-5670. M743 Medical Sciences Building.

JOINT EMERITUS FACULTY

HILLMAN, RICHARD E., Professor Emeritus of Child Health. M.D., Ph.D., Yale University. Inborn errors of amino acid metabolism in humans. (573) 884-7594. NW507 Medical Sciences Building.

ORTWERTH, BERYL J., Professor Emeritus of Ophthalmology. Ph.D. 1965, University of Missouri. Lens proteinases and proteinase inhibitors; cataractogenesis. (573) 882-6092. EC-212 Mason Institute of Ophthalmology.

ADJUNCT FACULTY

EDWARDS, JANICE WETTSTEIN, Adjunct Professor. Ph.D. 1986, University of Chicago. Director, Biotechnology, Nutrition & Consumer Sector, Monsanto Co. (314) 694-7742. 800 Lindbergh Blvd., St. Louis, MO 63167.

GRUYS, KENNETH, Adjunct Professor. Ph.D. 1984, University of Nebraska-Lincoln. Plant biotechnology. Monsanto Company, Calgene Campus, 1920 Fifth Street, Davis, CA 95616. (530)792-2213.

OULMASSOV, TIM N., Adjunct Assistant Professor. Ph.D. 1990, Institute of Molecular Genetics, Moscow, Russia. Plant Biotechnology. (314) 694-2101. Monsanto, 800 North Lindbergh, St. Louis, MO 63198

SAMUDZI, CLEOPAS, Adjunct Assistant Professor. Ph.D. 1990, University of Pittsburgh. Northwest Missouri State University, 800 University Drive, Maryville, MO 64468.

TILLITT, DONALD E., Adjunct Assistant Professor. Assistant Chief Chemist at U.S. Fish and Wildlife Service, Ph.D., 1989, Michigan State University. Biochemical indicators of contaminant stress in fish and wildlife (573) 875-5399. U.S. Fish & Wildlife Service, Rt 2, 4200 New Haven Rd, Columbia, MO 65201.

Appendix C
University of Missouri

20 Questions
Jan 2009 Biochemistry Department

I. PROTEINS AND ENZYMES

1. What are the principles and patterns of protein structure? Considering the electronic properties and spatial organization of the peptide unit as well as the principles of thermodynamics, describe the different levels of protein structure and common motifs of three-dimensional organization.

2. Give an overview of techniques used to determine the three-dimensional structures of proteins. For two specific techniques, describe the principles on which each is based, the nature of the data obtained and how the data are used to provide information about structure.

3. Describe four distinctly different covalent modifications of proteins, showing the chemistry of each reaction and describing the effect of the modification on protein function.

4. How does an enzyme increase the rate of a reaction? Describe at least three different mechanisms used by enzymes to do this.

5. Give an overview of biochemical techniques used to obtain information about the strength and/or stoichiometry of macromolecular interactions. For three different techniques describe the nature of the data obtained and how the data are used to provide information about interactions.

II. METABOLISM

1. Discuss the origins and roles of acetyl CoA in metabolism. How does acetyl CoA illustrate the principle of integrating diverse systems through shared chemical intermediates?

2. Describe the principles, components and biochemical steps involved in chemiosmotic phosphorylation. Explain the similarities and differences for this process in respiration and photosynthesis?

3. What are the roles and significance of feedback inhibition and repression in metabolic regulation? Illustrate with at least two distinctly different examples.

4. What are the control points for glycolysis and the TCA cycle? Consider the irreversible steps and those that yield ATP.

5. Compare the reactions, energetics, cellular localization and control of fatty acid oxidation and biosynthesis.

III. NUCLEIC ACIDS AND GENE REGULATION

1. What are the principles and patterns of nucleic acid structure? Starting with the chemistry of nucleic acids, describe the basis for secondary and tertiary structure, considering both DNA and RNA.

2. Describe basic principles and mechanisms of transcriptional control. Consider similarities and differences between eukaryotes and prokaryotes.

3. Discuss the role of small RNA's in control of gene expression.

4. What are the biochemical steps and energetics of DNA replication? How is fidelity of the DNA maintained during this process?

5. What are the processing steps involved in converting a nuclear transcript into a mature mRNA? Describe the biochemistry of these reactions.

IV. SUPRAMOLECULAR STRUCTURE AND CELLULAR ORGANIZATION

1. Explain the thermodynamic and biochemical basis of membrane organization and structure? How do the various membrane components interact and what are their respective roles?

2. Explain the condensation and organization of DNA into higher order structures. Describe the biochemical processes by which these structures can control gene expression,

3. Outline the different classes of structural organizations known for transmembrane receptors. For three different classes explain for each how signals are sent across the membrane and how the receptor initiates intracellular signaling.

4. Describe the biochemical processes of three distinctly different mechanisms of intracellular signaling. Explain how the lifetime of each signal is controlled.

5. Describe the ribosome, including its organization, three-dimensional structure and functional interactions with other molecules involved in the process of protein synthesis.