

Molecular Biology, Microbiology and Biochemistry

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COLLEGE OF SCIENCE/SCHOOL OF MEDICINE

Graduate Faculty:

Achenbach, Laurie, Professor and *Dean*, College of Science, Ph.D., University of Illinois, Urbana-Champaign 1988; 1990. Molecular genetics of metabolic pathways involved in the bioremediation of environmental contaminants; bacterial diversity and evolution; molecular anaerobic microbiology.

Bartholomew, Blaine, Professor, *Emeritus*, Ph.D., University of California, Davis; 1988; 1991. Regulation of gene expression, chromatin structure and function, molecular mechanisms of cancer.

Bartke, Andrzej, Professor, *Emeritus*, Ph.D., (Springfield), University of Kansas, 1965; 1984. Genetic control of aging in mammals and endocrine mechanisms responsible for the effects of longevity genes.

Bender, Kelly, Associate Professor and *Director*, MBMB Graduate Program, Ph.D., Southern Illinois University, 2003; 2006. Metabolic regulation of bacteria involved in bioremediation; small non-coding regulatory RNAs.

Bhaumik, Sukesh R., Associate Professor, Ph.D., Tata Institute of Fundamental Research (University of Bombay), 1997; 2003. Regulation of eukaryotic gene expression; transcription-coupled ubiquitination and DNA repair; NMR structural studies on proteins and nucleic acids.

Braundmeier-Fleming, Andrea, Assistant Professor, Ph.D., (Springfield), 2005; 2014. Immune cell function and influence on the GI and vaginal microbiome and their implication in reproductive disorders.

Cao, Deliang, Associate Professor, M.D., Ph.D., (Springfield), Institute of Molecular Biology (University of Hong Kong), 1996; 2005. Molecular oncology and experimental therapeutics, with focuses on 1) action mechanisms and modulations of anticancer therapeutic agents and 2) the role of aldo-ketoreductases in cancer development, progression and therapy.

Clark, David P., Professor, *Emeritus*, Ph.D., University of Bristol, 1977; 1980.

Cooper, Morris D., Professor, *Emeritus*, Ph.D., (Springfield), University of Georgia, 1971; 1973.

Davie, Judy, Associate Professor, Ph.D., University of California at Berkeley, 1998; 2006. Mechanisms of gene regulation, focusing on myogenin, a transcription factor that controls skeletal muscle development.

Elble, Randolph C., Associate Professor, Ph.D., (Springfield), Indiana University, 1986; 2005. Tumor suppression mechanisms in breast cancer. Biology of CLCA family proteins. Gene regulation in differentiation and stress.

Fisher, Derek, Assistant Professor, Ph.D., University of Pittsburgh School of Medicine, 2006; 2012. Developmental regulation in *Chlamydia*.

Fix, Douglas F., Associate Professor and *Chair*, Microbiology, Ph.D., Indiana University, 1983; 1987. Molecular mechanisms of mutagenesis in *Escherichia coli*.

Gagnon, Keith T., Assistant Professor, Ph.D., North Carolina State University, 2007; 2014. Biochemistry of nucleic acids, RNA and RNA-protein interactions in human biology and disease.

Gershburg, Edward, Associate Professor, Ph.D., (Springfield), Tel-Aviv University, 1999; 2007. Epstein-Barr virus (EBV)-encoded protein kinase in viral infection. EBV-PK regulation and enzymology and identification of its viral and cellular targets.

Gupta, Ramesh, Professor and *Chair*, Biochemistry and Molecular Biology, Ph.D., University of Illinois, 1981; 1984. Molecular biology of Archaea, transcription and RNA processing in extreme halophilic and hyperthermophilic microorganisms.

Haddock, John D., Associate Professor, *Emeritus*, Ph.D., Virginia Polytechnic Institute and State University, 1990; 1995.

Halford, William, Associate Professor, Ph.D., (Springfield), Louisiana State University Medical Center, 1996; 2007. Using herpes simplex virus as a tool to understand how viral and host immune factors interact to produce life-long viral infections; devising effective cures for persistent viral infections.

Hamilton-Brehm, Scott D., Assistant Professor, Ph.D., University of Georgia, 2008; 2016. Microbial characterization of unique extreme environments, characterization of novel metabolism pathways, and DNA investigations from ancient artifacts.

Hardwicke, Peter M. D., Professor, *Emeritus*, Ph.D., Kings College, London, 1969; 1985. Regulation of calcium transport across membranes by calcium pumps and the sodium-calcium exchanger. Proteolipids, lipids, conjugated trienes and non-myelin sensory nerve antigens.

Huvos, Piroaska, Research Assistant Professor, Ph.D. Eotvos Lorand University, Budapest, 1969; 1987. Genome rearrangements.

Kadyrov, Farid, Associate Professor, Ph.D., Russian Academy of Sciences, 1997; 2008. DNA replication and repair, DNA damage in cancer.

Konjufca, Vjollca, Assistant Professor, Ph.D., University of Arkansas, Fayetteville, 2002; 2010. Immunology, host-pathogen interactions.

Madigan, Michael T., Professor and Distinguished Scholar, *Emeritus*, Ph.D., University of Wisconsin, 1976; 1979.

Martinko, John M., Associate Professor and Distinguished Teacher, *Emeritus*, Ph.D., SUNY (Buffalo), 1978; 1981.

Nie, Daotai, Professor, Ph.D., (Springfield), University of South Carolina, 1997; 2005. Molecular and cellular biology of cancer; tumor metastasis; development of tumor therapeutics.

Niederhoffer, Eric C., Associate Professor, Ph.D., Texas A&M University, 1983; 1990. Metallobiochemistry; electron transfer; metalloprotein structure-function, microbial stress responses-virulence factors.

Olson, Michael, Assistant Professor, Ph.D., (Springfield), University of Nebraska Medical Center, 2009; 2014. Characterization of the biology of *Staphylococcus Aureus* at the host interface.

Parker, Jack, Professor, *Emeritus*, Ph.D., Purdue University, 1973; 1977.

Rader, Bethany, Assistant Professor, Ph.D., University of Oregon, 2006; 2014. Beneficial host-microbe interactions, innate immunology, microbial ecology and systems biology.

Ran, Sophia, Professor, Ph.D. (Springfield), Weizmann Institute of Science, 1989; 2003. Tumor physiology, angiogenesis and lymphangiogenesis; breast cancer metastasis.

Rao, Krishna, Associate Professor, M.D., Ph.D., (Springfield), University of Washington, 2002; University of Miami, 1991; 2007. Role of Rab25 as a tumor suppressor, treatment of head and neck cancer.

Schmit, Joseph C., Associate Professor, *Emeritus*, Ph.D., Purdue University, 1971; 1976.

Tischkau, Shelly A., Associate Professor, Ph.D., (Springfield), University of Illinois, Urbana-Champaign, 1995; 2007. Neuroendocrinology; environmental toxicology; regulation of molecular circadian rhythms in health and disease states, including cancer and diabetes.

Torry, Donald S., Professor and *Chair of Medical Microbiology, Immunology and Cell Biology*, Ph.D., (Springfield), Southern Illinois University, 1989; 2000. Human reproductive biology; cellular biology of angiogenic growth factors and immune cytokines during pregnancy. Molecular biology of placental gene expression.

Weilbaecher, Rodney, Research Assistant Professor, Ph.D., University of California, Berkeley, 1997; 2007. Gene regulation, post-translational modifications, telomere biology.

Wilber, Andrew, Assistant Professor and *Director of Public Health Laboratory Sciences Program*, Ph.D., (Springfield) University of Minnesota, 2006; 2008. Gene therapy for hemoglobin disorders beta-thalassemia and sickle cell anemia, gene expression regulation, stable gene delivery using non-viral and viral integrating vector systems and cancer immunotherapy.

Yuan, Rong, Assistant Professor, M.D., Ph.D., (Springfield), Shanghai Second Medical University, P.R. China, 2000; 2012. Molecular Biology of aging and longevity.

Graduate programs are offered that lead to the Doctor of Philosophy (Ph.D.) and Master of Science (M.S.) in Molecular Biology, Microbiology and Biochemistry. The M.S. degree has thesis and non-thesis options. The non-thesis option M.S. degree has an area of specialization in Public Health Laboratory Sciences. These interdisciplinary programs draw their faculty primarily from the Department of Microbiology (College of Science) and the Department of Biochemistry and Molecular Biology (School of Medicine) on the Carbondale campus, and the Department of Medical Microbiology, Immunology, and Cell Biology (School of Medicine) on the Springfield campus. Adjunct faculty from the Illinois Department of Public Health (IDPH) Division of Laboratories provide training to students in the public health laboratory setting. The programs are designed to offer advanced training (via lecture, discussion and laboratory) in biochemistry, biophysics, bacteriology, genetics, immunology, microbial physiology, virology, mycology, molecular biology, cell biology, developmental biology, structural biology and public health laboratory science. The Ph.D. and thesis option M.S. programs require laboratory research. The non-thesis option M.S. degree program is designed to prepare students for a career in public health laboratory science and requires substantial training in a public health laboratory setting that is directly relevant to career preparation in that area.

Admission

Prospective graduate students should have an undergraduate degree in any of the biological, chemical or physical sciences. The applicants are recommended to have completed courses in biology, organic chemistry, physics and mathematics. Strong candidates with deficiencies in any area may be admitted, but such deficiencies may restrict the research areas available to the student and may lead to requirements for additional courses during graduate study. An advisory system in the program (see below) will help students in planning their course of study. Prospective students for the thesis option M.S. and Ph.D. degrees are encouraged to contact program faculty in areas of their research interest. Prospective students seeking admission to the non-thesis option M.S. degree program with an area of concentration in public health laboratory science are encouraged to contact the Chair of the Public Health Science Program committee.

Students may be admitted to the doctoral program with a bachelor's or master's degree. Students in the thesis option M.S. program can be admitted to the doctoral program via accelerated entry or the master's equivalency option by the recommendation of the faculty and approval of the Graduate School.

All application materials should be submitted to the Program Director. This program requires a nonrefundable \$65 application fee that must be submitted with the application for Admissions to Graduate Study in Molecular Biology, Microbiology and Biochemistry. Applicants must pay this fee by credit card. Applications for admission to the thesis option M.S. and Ph.D. programs are evaluated by the M.S./Ph.D. Program Admissions Committee and applications for the non-thesis option M.S. degree program with an area of concentration in public health laboratory science are evaluated by the Public Health Science Program Committee. Upon recommendation of the appropriate committee, the application is transmitted to the Graduate School for approval.

The MBMB program requires a grade point average (GPA) of 2.7 ($A = 4.0$) for admission into the M.S. programs and a GPA of 3.00 in graduate level work for admission into the doctoral program. An excellent record in undergraduate coursework and a strong recommendation of the thesis option M.S./Ph.D. Program Admissions Committee is required for direct admission to the doctoral program after a bachelor's degree.

Applicants are required to submit Graduate Record Examination (GRE) general test scores. Submission of test scores of the GRE advanced (biochemistry, cell and molecular biology or biology or chemistry) examinations is also encouraged.

International students whose native language is not English will be required to obtain at least 550 (paper score), 213 (computer score) or IBT of 80 on the Test of English as a Foreign Language (TOEFL) or 6.5 on the International English Language Testing System (IELTS).

Financial Assistance

Fellowships and assistantships are available through the program and the participating departments for qualified applicants.

Advisement and General Requirements

For thesis option M.S. and Ph.D. students, the Program Director or the Departmental Graduate Advisors as designates

will assist each incoming student with the initial planning of a program of study and will advise the student until a Research Director is chosen. For non-thesis option M.S. degree program students, the Public Health Science Program Committee or its Chair will assist students in the planning of a program of study.

Research Director and Graduate Committee Selection.

Each student in the Ph.D. or thesis option M.S. program should select a Research Director as soon as possible during the first year. The graduate committee for thesis option M.S. students shall consist of the Research Director (chair), and two additional graduate faculty members. The graduate committee for Ph.D. students shall consist of at least five graduate faculty members to include the Research Director (committee chair), three members derived from participating departments and one member from outside the Program. The Program Director, if not otherwise appointed, is an ex-officio (non-voting) member of every graduate committee. Students in the non-thesis option M.S. degree program with an area of concentration in public health laboratory science program need not choose a Research Director or a Graduate Committee and the Public Health Science Program Committee will plan and monitor student progress through the non-thesis option M.S. program.

Graduate Committee Functions (thesis option M.S. and Ph.D. students only). The graduate committee will:

1. plan and approve the student's program of study.
2. review the student's progress in courses and suggest and approve changes in the program of study.
3. evaluate the student's progress in research and make appropriate recommendations.
4. meet and determine, on a yearly basis, whether a student is making satisfactory progress and may continue toward a degree. If continuation is denied, the committee must notify the Program Director, in writing, of the reasons for this denial.
5. administer written and oral preliminary examinations to the doctoral student.
6. read and evaluate the student's thesis or dissertation.
7. conduct the required oral examinations.

Public Health Laboratory Science Program Committee (non-thesis M.S. students only). The Public Health Laboratory Science Program Committee is composed of a Chair and a single member chosen from each of the three departments participating in the MBMB program. The Public Health Laboratory Science Program Committee will:

1. Provide programmatic oversight of the structure, curricular design, content and personnel involved in the non-thesis option M.S. program.
2. Review applications from students for admission to the non-thesis option M.S. program and make admissions recommendations to the MBMB Program Director.
3. Advise non-thesis option M.S. students in planning a course of study.
4. Monitor student progress toward the non-thesis option M.S. degree.

Formal Course Requirements. All course requirements of the MBMB degree programs and Graduate School are minimum requirements. Additional courses may be required by the student's graduate committee (thesis option M.S. and Ph.D. students) or the Public Health Laboratory Science Program Committee (non-thesis option M.S. students) to meet any deficiencies or to provide proficiency in a specialized area. Certain courses are required of all students, while others meet the requirements of an individual student's area of specialization, as determined by the student's graduate committee (thesis option M.S. and Ph.D. students). The Program Director, with the advice of the student's graduate committee or the Public Health Laboratory Science Program Committee may designate other courses within or outside of the Program to fulfill formal course requirements. Any course (or its equivalent) that meets the requirements of the Molecular Biology, Microbiology and Biochemistry graduate program whether taken at SIU or at any other institution before admission to the Program need not be repeated. Course equivalency will be determined by the Program Director in consultation with the appropriate committee or member of the faculty.

The formal core course requirements for both the thesis option M.S. and Ph.D. degree can be met by taking either MBMB 451A,B, and 460; or their equivalent. All M.S. and Ph.D. students must take either MBMB 502, Introduction to Research, or MBMB 504, Research Methods, and must also take during each semester in residence one hour of MBMB 597, Seminar and Professional Training.

Thesis option M.S. students must take two courses and the doctoral students must take three courses from a list of approved courses for specialization. Only one 400-level course from this list can be used to meet this requirement. Currently this list consists of: MBMB 403, 405, 421, 423, 425, 441, 453, 455, 456, 470, 477, 520, 530, 531, 532, 533, 543, 551, 552, 553, 560, and 562. These courses are selected with the approval of the student's graduate committee, Research Director or the Departmental Graduate Advisor. In addition, M.S. students are also required to earn at least eight hours in research and thesis credit (MBMB 515, 598 and 599; a minimum of three and maximum of six hours for MBMB 599), prepare a thesis on the research project and pass a final oral examination, which serves as the comprehensive examination.

The formal course requirements for non-thesis option M.S. students with an area of specialization in public health laboratory sciences can be met by taking: MBMB 403 or 405, 453 or 455, 451A, 451B, CHEM 431, MBMB 460, 510, 540, 541A and 541B. Non-thesis option M.S. students must also take one hour of MBMB 597 (Seminar and Professional Training) during each semester in residence. The Public Health Laboratory Science Program Committee will make recommendations to the Program Director whether courses taken at SIU or other universities are equivalent to the program requirements.

Preliminary Examination and Dissertation for the Ph.D. Degree. Each student in the doctoral program must pass a preliminary examination and meet the Graduate School residency requirement before being advanced to candidacy. The students can take the preliminary examination after completing the formal course requirements.

The student's graduate committee will prepare and administer a written preliminary examination covering various areas of molecular biology, microbiology and biochemistry, with particular emphasis in the area of concentration declared. This declaration will be done by means of a prospectus of a dissertation composed of: (1) a proposal for the dissertation research, (2) biographical information on the candidate, and (3) a list of the courses taken during the candidate's graduate program. The proposal should address the proposed graduate research project, and be written in the NIH (National Institutes of Health) or NSF (National Science Foundation) approved format. The prospectus shall be available to the committee members at least 14 days prior to the date of the examination.

A written examination score of at least 80percent is required before a student can proceed to the oral portion of the preliminary examination. Upon satisfactory completion of the written examination, the candidate will meet with the committee as a whole and discuss the prospectus in detail. The committee will then conduct an oral preliminary examination. At this time, the committee may ask in-depth questions about the research project and other areas of molecular biology, microbiology and biochemistry. At least four of the five committee members must judge the oral performance acceptable for a student to pass the preliminary examination overall. In the event that either the written or oral preliminary examination is failed, a student may request only one re-examination.

Successful completion of both written and oral examinations is required before a student can be advanced to candidacy for the Ph.D. After admission to candidacy, the student must earn at least 24 dissertation credit hours (MBMB 600), prepare and defend a dissertation, and present a public seminar based on the student's research.

Courses (MBMB)

MBMB 403-3 Medical Microbiology Lecture. (Same as MICR 403) A survey of the more common bacterial, mycotic and viral infections of humans with particular emphasis on the distinctive properties, pathogenic mechanisms, epidemiology, immunology, diagnosis and control of disease-causing microorganisms. Three hours lecture. Spring semester. Prerequisite: MICR 301, or consent of instructor.

MBMB 405-3 Clinical Microbiology. (Same as MICR 405) This course will be offered in Springfield only. A comprehensive course for health science professionals covering the biology, virulence mechanisms, and identification of infectious agents important in human disease and host-defense mechanisms. Clinical applications emphasized. Three hours lecture. Prerequisite: MICR 301, or consent of instructor.

MBMB 421-3 Biotechnology. (Same as MICR 421) Topics covered will include the genetic basis of the revolution in biotechnology, medical applications including genetic screening and therapeutic agents, industrial biotechnology and fermentation, and agricultural applications. Three hours lecture. Fall semester. Prerequisite: MICR 302, or consent of instructor.

MBMB 423-3 Geomicrobiology. (Same as MICR 423 and GEOL 423) The course will focus on the role that microorganisms play in fundamental geological processes. Topics will include an outline of the present understanding of microbial involvement of weathering of rocks, formation and transformation of soils

and sediments, and genesis and degradation of minerals. Elemental cycles will also be covered with emphasis on the interrelationships between the various geochemical cycles and the microbial trophic groups involved. Prerequisite: MICR 301 and CHEM 210 and 211. Recommended: GEOL 220, 221 or 222.

MBMB 425-3 Biochemistry and Physiology of Microorganisms Lecture. (Same as MICR 425) Chemical composition, cellular structure, and metabolism of microorganisms. Fall semester. Prerequisite: CHEM 340 or CHEM 339.

MBMB 441-3 Viruses and Disease. (Same as MICR 441) An intensive, lecture-based course in virology which will emphasize principles of molecular virology, the ubiquity of viruses in nature, evolutionary relationships between viruses, co-evolution between virus and host, and the pathogenic consequences of some viral infections (e.g., AIDS, hepatitis, cancer, etc.). Prerequisites: MICR 460 or MBMB 460 or consent of instructor.

MBMB 451A-3 Biochemistry. (Same as CHEM 451A and BCHM 451A) First half of the 451 A,B two semester course. Must be taken in A,B sequence. Three lectures per week. Introduction to biomolecules, biochemical techniques, expression of genetic information, basic thermodynamics, ligand binding, aqueous solutions, protein structure, spectroscopy. Prerequisites: CHEM 340 and CHEM 342 or 442, or equivalents.

MBMB 451B-3 Biochemistry. (Same as CHEM 451B and BCHM 451B) Second half of 451A,B two semester course. Must be taken in A,B sequence. Basic kinetics, enzyme kinetics, enzyme inhibitors, regulation of enzymes, oxidation-reduction, high energy bonds, transport across membranes, intermediary metabolism, hormonal control of metabolism. Prerequisites: MBMB 451A or BCHM 451A or CHEM 451A or equivalent.

MBMB 453-3 Immunology Lecture. (Same as MICR 453) Principles of molecular and cellular immunology. Particular emphasis is given to molecular mechanisms involved in activation and maintenance of the immune response at the basic science level. The role of the immune system in medical diagnostic procedures and in human health is also discussed. Spring semester. Prerequisite: MICR 403, or consent of instructor.

MBMB 455-2 Medical Immunology. (Same as MICR 455) This course will be offered in Springfield only. A survey of the components of the immune system and how they interact with each other to produce responses that are important in the control or mediation of human disease. Two hours lecture. Prerequisite: MICR 301, or consent of instructor.

MBMB 456-3 Biophysical Chemistry. (Same as CHEM 456 and BCHM 456) A one-semester course in Biophysical Chemistry intended for biochemists and molecular biologists. Emphasis will be on solution thermodynamics, kinetics and spectroscopy applied to biological systems. Prerequisite: CHEM 340 and CHEM 342 or 442, MATH 141 or 150, MBMB 451A or BCHM 451A or CHEM 451A, or equivalents.

MBMB 460-3 Bacterial and Viral Genetics. (Same as MICR 460) The genetic mechanisms and regulatory events that control gene transfer, lambda phage infection, recombination, and metabolic pathways including a brief introduction to bioinformatics, genome analysis and global regulatory functions. Three hours lecture. Fall semester. Prerequisite: MICR 301 and 302, or consent of instructor.

MBMB 470-3 Prokaryotic Diversity Lecture. (Same as MICR 470) A consideration of the major groups of prokaryotes with special emphasis on their comparative physiology and ecology. Three hours lecture. Spring semester. Prerequisite: MICR 301, or consent of instructor.

MBMB 477-3 Microbial Ecology. (Same as MICR 477) Concepts of ecology applied to microorganisms; methods in microbial ecology; interactions of microbes with their living and non-living environment microbial habitats and functions. Roles and regulation of microbes in natural and man-made environments, from cellular to community level. Prerequisite: MICR 301 or instructor's consent (based on proven background in both microbiology and ecology).

MBMB 480-4 Molecular Biology of Microorganisms Laboratory. (Same as MICR 480) Genetic and biochemical analyses of microorganisms using a variety of techniques in molecular biology, molecular genetics and biotechnology. Six hours laboratory per week plus two hours of supervised unstructured laboratory work in most weeks. Fall semester. Prerequisite: MICR 301 and 302 with a C grade or better and two (or concurrent enrollment in two) of the following: 421, 423, 425 or 460. Lab fee: \$60.

MBMB 481-4 Diagnostic and Applied Microbiology Laboratory. (Same as MICR 481) Enrichment and isolation of prokaryotes from natural samples, diagnostic methods for the identification of pathogenic bacteria, and the nature of the immune response. Six hours laboratory per week plus two hours supervised unstructured laboratory work in most weeks. Spring semester. Prerequisite: MICR 301 and 302 with a C grade or better and two (or concurrent enrollment in two) of the following: 403, 453 or 470. Lab fee: \$60.

MBMB 502-3 Introduction to Research. An introductory research course. Students rotate through at least three research laboratories. Lecture and laboratory hours to be arranged. Students cannot get credit for both MBMB 502 and MBMB 504. Restricted to acceptance into the Molecular Biology, Microbiology and Biochemistry graduate program.

MBMB 504-3 Research Methods. Problem definition, experimental design and research methods in specific areas of molecular biology, biochemistry and microbiology. Lecture and laboratory hours to be arranged. Students cannot get credit for both MBMB 502 and MBMB 504. Restricted to acceptance into the Molecular Biology, Microbiology and Biochemistry graduate program.

MBMB 505-1 Special Topics. Discussion of current research in specific areas of molecular biology, microbiology and biochemistry. One hour of group discussion per week. Special approval needed from the instructor.

MBMB 510-3 Functions of Public Health System. This course is an introduction to the concepts and practices of public health at the community, state, and national levels. The course addresses the philosophy, purpose, history, organization, functions, activities and impact of public health practice. The course also addresses a number of important health issues and problems facing the public health system. Special emphasis will be placed on the role of public health laboratory in public health practice. Discussion questions and case studies are integrated into the course, serving to stimulate student participation in gaining in-depth knowledge about real world public health issues and practice. Prerequisite: Bachelor's degree in Microbiology or

other Biology, Chemistry, Physical Science.

MBMB 515-1 to 6 (1 to 6 per semester) Master's Degree Research. Individualized laboratory research and training. Graded credit for Master's Degree only. Maximum 6 credit hours. Restricted to admission to master's program in Molecular Biology, Microbiology and Biochemistry. Special approval needed from the instructor.

MBMB 520-2 Advanced Microbial Physiology and Control Mechanisms. The physiology, biochemistry and genetics of microbial regulatory mechanisms. Topics include transport phenomena, catabolite and nitrogen repression, the stringent response, and autoregulatory phenomena. Two lectures per week. Prerequisite: MBMB 425; or CHEM 451A and B, or consent of instructor.

MBMB 521-3 Advanced Virology. An advanced, lecture-based course which will (1) emphasize principles of molecular virology, (2) discuss immune responses to viral infections, (3) learn how viral infections can be prevented or treated, and (4) explore how some viruses can be used as therapeutic agents. Each topic will include an in-depth discussion of current research literature. Prerequisites: 400 level course in genetics and in biochemistry, or consent of the instructor.

MBMB 528-1 to 3 Special Readings in Molecular Biology, Microbiology and Biochemistry. Supervised readings for qualified graduate students. Special approval needed from the instructor.

MBMB 530-3 Advanced Cellular Biology. (This course will be offered in Springfield only). An advanced course based on current literature concerning the cellular biology of eukaryotes. Both students and faculty will make presentations followed by discussion. Topics will include: the cellular and subcellular structure and function of the lower eukaryotes, the biochemistry and biophysics of eukaryotic membrane systems and the higher subcellular functions of mammalian cells. Prerequisite: 400 level course in genetics and in biochemistry or consent of instructor.

MBMB 531-3 Molecular and Cellular Biology. Lecture course in molecular and cellular biological techniques used in the study of organisms; structures and processes involved in genome organization; packaging and replication of DNA; transcription and RNA processing; recombination and transposition of DNA; gene regulation with emphasis on developmental processes; signal transduction; structure and function of cellular components; cell-cell interaction; etc. Prerequisite: BCHM 451B or consent of instructor; MBMB or MICR 460 recommended.

MBMB 532-3 Methods of Structural Biology. Lecture course in molecular computer graphics, macromolecular structure prediction, molecular dynamics, applications of NMR and X-ray methods to structural determinations of biological macromolecules; spectroscopic methods including UV, IR, Raman, fluorescence and circular dichroism methods. Prerequisite: BCHM 456 or consent of instructor.

MBMB 533-3 Advanced Biochemistry. Lecture course in control mechanisms of biochemical processes, enzyme kinetics, regulation and allostery, coupled systems and energy transduction, membranes, transport, etc. Prerequisite: BCHM 451A or consent of instructor.

MBMB 540-3 Basis of Public Health Laboratory Practice. The scientific basis of current laboratory practice of public health science in the areas of microbiology, immunology,

molecular biology, environmental chemistry, biochemistry and instrumentation (to accompany 541A,B). Prerequisite: MBMB 510, Bachelor's degree in Biology, Chemistry, Physical Science.

MBMB 541A-3 to 9 Public Health Laboratory Training. This course has a laboratory component of approximately 4-6 hours/week/credit hour of training in a functioning public health laboratory. The content of the course provides in-depth experience in the scientific basis and use of analytical methods in microbiology, immunology and molecular biology that are unique to public health laboratories at the state and national level. Prerequisite: MBMB 510, concurrent with MBMB 540, MICR 301 or equivalent.

MBMB 541B-3 to 9 Public Health Laboratory Training. This course has a laboratory component of approximately 4-6 hours/week/credit hour of training in a functioning public health laboratory. The content of the course provides in-depth experience in the scientific basis and use of analytical methods in environmental chemistry and biochemistry that are unique to public health laboratories at the state and national level. Prerequisite: MBMB 510, MBMB 541A.

MBMB 543-3 Host-Microbial Interactions. (This course will be offered in Springfield only). A lecture course that deals in depth with mechanisms of symbiosis and other interactions with respect to the biochemistry of microbe and host. Immunological aspects are discussed. Emphasis is placed on molecular mechanisms. Offered alternate years. Prerequisite: MBMB 403 or MBMB 405 or consent of instructor.

MBMB 551-3 Advanced Immunology. A lecture course that intensively considers the most recent developments in antibody structure, antigenic analysis, and antigen-antibody reactions. A special focus will be on the use of immunology as a research tool. Prerequisite: MBMB 453 or equivalent, or consent of instructor.

MBMB 552-3 Cellular Immunology. (This course will be offered in Springfield only). A lecture-discussion course covering contemporary aspects of cellular immunology. The cellular nature of immune responses as well as current information on the regulation of such responses will be considered. Topics will include cellular components of an immune response; receptors, recognition and signals; cellular cooperation; immune regulation; and tolerance and autoreactivity. Prerequisite: MBMB 453 or MBMB 455 or consent of instructor.

MBMB 553-3 Advanced Medical Microbiology and Immunology. (Offered in Springfield only). A lecture course providing an in-depth analysis of the mechanisms of pathogenesis of bacterial, viral and mycotic infections. Immune mechanisms involved in recovery, development of immunity and infection mediated immunopathology will be covered. Prerequisite: MBMB 403 and MBMB 453; or MBMB 405 and MBMB 455; or consent of instructor.

MBMB 554-1 to 4 (1 per semester) Evolution Seminar. (Same as ANTH 554, PLB 554) Advanced topics in evolutionary biology including genetics & development, evolutionary ecology, phylogeny, paleontology, biogeography, population genetics, molecular ecology, speciation, molecular evolution, and macroevolution. Topics will vary each semester. Seminar format with group discussions and student presentations. Graded S/U. Special approval needed from the instructor.

MBMB 556-3 Phylogenetics. (Same as ANTH 556, PLB 556, ZOO 556) An advanced introduction to modern methods

of phylogenetic inference, emphasizing both theoretical background concepts and numerical approaches to data analysis. Topics include properties of morphological and molecular characters, models of character evolution, tree estimation procedures, and tree-based testing of evolutionary hypotheses. Special approval needed from the instructor.

MBMB 560-3 Molecular Oncology. A lecture-discussion course in molecular and cellular biology of tumor pathogenesis. The lecture covers various aspect of current tumor biology. The in-depth discussion on recent articles will provide students with opportunity to become familiar with front-line research in molecular oncology. Prerequisite: MBMB 451A and B or consent of instructor.

MBMB 562-3 Molecular Genetics. A lecture and discussion course emphasizing current research and new techniques in replication, transcription, translation, genome organization, gene flow from a general systems viewpoint and regulation. Prerequisite: MBMB 460 or consent of instructor.

MBMB 568-1 Current Topics in Oncology. A seminar-discussion course covering the pace-setting topics in oncology research. The topics will be selected by the course director. Students will research and select articles to be presented for discussion. The in-depth discussion on recent articles will provide students with opportunity to become familiar with cutting edge line research in oncology. Prerequisite: MBMB 560 or consent of instructor.

MBMB 570A-1 to 15 (1 to 6 per semester) Advanced Topics-Molecular Biology. Selected topics of current scientific interest to the faculty and students. Specific topic to be covered in any semester will be announced. Special approval needed from the instructor.

MBMB 570B-1 to 15 (1 to 6 per semester) Advanced Topics-Biochemistry. Selected topics of current scientific interest to the faculty and students. Specific topic to be covered in any semester will be announced. Special approval needed from the instructor.

MBMB 570C-1 to 15 (1 to 6 per semester) Advanced Topics-Microbiology. Selected topics of current scientific interest to the faculty and students. Specific topic to be covered in any semester will be announced. Special approval needed from the instructor.

MBMB 570D-1 to 15 (1 to 6 per semester) Advanced Topics-Immunology. Selected topics of current scientific interest to the faculty and students. Specific topic to be covered in any semester will be announced. Special approval needed from the instructor.

MBMB 570E-1 to 15 (1 to 6 per semester) Advanced Topics-Virology. Selected topics of current scientific interest to the faculty and students. Specific topic to be covered in any semester will be announced. Special approval needed from the instructor.

MBMB 570F-1 to 15 (1 to 6 per semester) Advanced Topics-Structural Biology. Selected topics of current scientific interest to the faculty and students. Specific topic to be covered in any semester will be announced. Special approval needed from the instructor.

MBMB 570G-1 to 15 (1 to 6 per semester) Advanced Topics-Biophysics. Selected topics of current scientific interest to the faculty and students. Specific topic to be covered in any semester will be announced. Special approval needed from the instructor.

MBMB 570H-1 to 15 (1 to 6 per semester) Advanced Topics-General Cell Biology. Selected topics of current scientific interest to the faculty and students. Specific topic to be covered in any semester will be announced. Special approval needed from the instructor.

MBMB 580-1 Current Topics in Evolution. (Same as ANTH 580, ZOOL 580) The Evolution Discussion Group meets weekly throughout the year to discuss current evolutionary literature and the research of participants. All students and faculty with an interest in evolutionary biology are welcomed to participate.

MBMB 597-1 to 15 (1 per semester) Seminar and Professional Training. Departmental seminars, and other appropriate professional assignments. Graded S/U only. One hour required each semester in residence. Restricted to graduate standing.

MBMB 598-1 to 66 (1 to 12 per semester) Research. Graded S/U only. Special approval needed from the instructor.

MBMB 599-1 to 6 (1 to 6 per semester) Thesis. Research for Master's degree thesis. Special approval needed from the instructor.

MBMB 600-1 to 36 (1 to 12 per semester) Dissertation. Research for Ph.D. degree dissertation. Special approval needed from the instructor.

MBMB 601-1 (1 per semester) Continuing Enrollment. For those graduate students who have not finished their degree programs and who are in the process of working on their dissertation, thesis, or research paper. The student must have completed a minimum of 24 hours of dissertation research, or the minimum thesis, or research hours before being eligible to register for this course. Concurrent enrollment in any other course is not permitted. Graded S/U or DEF only.