Department of Biological, Chemical and Physical Sciences

Life Sciences Building
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Chicago, IL 60616
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www.iit.edu/csl/bcps

Associate Chairs:
Grant Bunker, Physics
Benjamin C. Stark, Biology
Rong Wang, Chemistry

The Department of Biological, Chemical and Physical Sciences offers B.S., M.S. and Ph.D. degrees in the fields of chemistry, biology, physics, and molecular biochemistry and biophysics. Within the department, there are many opportunities for interdisciplinary education and research experiences; students in any of the disciplines have easy access to the expertise that the full faculty brings. In addition, the department offers several professional masters degrees and related certificate programs for part-time students, both on campus and through distance learning.

Degrees Offered

Master of Biology with specialization in:
- Biochemistry
- Biotechnology
- Cell and Molecular Biology
- Microbiology

Master of Science in Biology with specialization in:
- Biochemistry
- Biotechnology
- Cell and Molecular Biology
- Microbiology

Master of Science in Molecular Biochemistry and Biophysics
Master of Chemistry
Master of Chemistry in Analytical Chemistry
Master of Chemistry in Materials and Chemical Synthesis
Master of Science in Chemistry
Master of Health Physics
Master of Science in Physics
Doctor of Philosophy in Biology
Doctor of Philosophy in Chemistry
Doctor of Philosophy in Molecular Biochemistry and Biophysics
Doctor of Philosophy in Physics

Certificate Programs

Analytical Method Development
Analytical Spectroscopy
Characterization of Inorganic and Organic Materials
Chromatography
Radiological Physics
Synthesis and Characterization of Inorganic Materials
Synthesis and Characterization of Organic Materials

Research Centers

Center for Synchrotron Radiation Research and Instrumentation
Center for Accelerator and Particle Physics
Center for the Molecular Study of Soft and Condensed Matter

Research Facilities

The department has state-of-the-art computer and laboratory equipment and conducts research in the areas of biochemistry, biotechnology, cell and molecular biology, microbiology, molecular biophysics and biochemistry; analytical chemistry, inorganic chemistry, solid-state and materials chemistry, organic chemistry, polymer chemistry, surface chemistry, physical chemistry and theoretical chemistry; and elementary particle physics, accelerator and plasma physics, condensed-matter physics, biological physics, x-ray optics, x-ray imaging and quantum theory. The department constructs and operates facilities for x-ray scattering, spectroscopy and imaging at the Advanced Photon Source at Argonne National Laboratory. Additional research facilities include on-campus x-ray diffraction facilities, thin-film growth facilities, a high-field nuclear magnetic resonance facility, state-of-the-art inorganic-, organic- and polymer synthesis and characterization laboratories, Fourier transform infrared spectrometers, atomic force microscope, mass spectrometers, and facilities for high-pressure liquid chromatography and gas chromatography. Laboratories for experimental research in biophysics, low-temperature, solid-state physics and particle physics are active. Collaborative programs are carried on with Fermi National Accelerator Laboratory, Argonne National Laboratory, and the Advanced Photon Source. The department hosts the Center for Accelerator and Particle Physics (CAPP), the Center for Synchrotron Radiation Research and Instrumentation (CSRRI), and the Center for the Molecular Study of Soft and Condensed Matter.

Faculty

Biology Faculty

Tanya I. Bekyarova, Senior Lecturer, and Director of the Master of Biology Program. M.S., University of Plovdiv; Ph.D., Illinois Institute of Technology. Macromolecular structure. Biochemistry, Cell and Molecular Biology.

Douglas J. Cork, Professor. B.S., M.S., Ph.D., University of Arizona. Biotechnology and bioremediation, microbial metabolism of xenobiotics, informatics. Microbiology, Biotechnology.

Michael Cummings, Research Professor. B.S., St. Mary's University; Ph.D., Northwestern University. Research on human chromosome organization and the development of innovative methods for teaching biology. Cell and Molecular Biology.

Mitchell Dushay, Assistant Professor. B.S., Brown University; Ph.D., Brandeis University. Drosophila genetics, immunology, eukaryotic transcription. Cell and Molecular Biology.

Andrew Howard, Associate Professor and Director of the Health Physics Program. B.A., Pomona College; Ph.D., University of California, San Diego. Structure and function of immune system proteins, macromolecular crystallography. Biochemistry, Molecular Biochemistry and Biophysics.

Thomas C. Irving, Professor and Director of the Biophysics Collaborative Access Team. B.Sc., M.Sc., Ph.D., University of Guelph (Canada). Structure and biophysics of macromolecular systems, muscle structure and physiology, synchrotron radiation instrumentation. Biochemistry, Molecular Biochemistry and Biophysics.

John Kilbane II, Research Professor. B.S., Ohio State University; Ph.D., Tufts University. Biological removal of sulfur from petroleum; genetic engineering of bacteria for bioremediation. Microbiology, Biotechnology.

David L. McCormick, Professor, and Senior Vice President and Director of the IIT Research Institute. B.A., Middlebury College; Ph.D., New York University. Preclinical development of drugs for the prevention and therapy of cancer. Cell and Molecular Biology.

Rajendra Mehta, Professor and Assistant Vice President of the IIT Research Institute. B.Sc., Gujurat Univeristy; Ph.D., University of Nebraska-Lincoln. Efficacy and mechanism of action of chemopreventive agents in experimental carcinogenesis of breast, colon, lung and prostate. Cell and Molecular Biology.

Nick Menhart, Associate Professor. B.Sc., Ph.D., University of Waterloo (Canada). Spectroscopic techniques for the study of multi-domain proteins. Biochemistry, Molecular Biochemistry and Biophysics.

Genoveva Murillo, Research Assistant Professor. B.S., M.S., Ph.D., University of Illinois, Chicago. Nutritional modulation of carcinogenesis of the colon and other tissues; cancer chemoprevention. Cell and Molecular Biology.

Joseph Orgel, Assistant Professor. B.Sc., Ph.D., University of Stirling (Scotland). Study of fundamental structural biochemistry problems that have direct links to the understanding and treatment of disease, primarily of the extracellular matrix of mammals. Biochemistry, Molecular Biochemistry and Biophysics.

Kathryn M. Spink, Senior Lecturer. B.S., Michigan Technological University; Ph.D., Michigan State University. Molecular genetics of mammalian viruses. Cell and Molecular Biology, Microbiology.

Benjamin C. Stark, Professor and Associate Chair of the Department. B.S., University of Michigan; M.Ph., Ph.D., Yale University. Biochemistry and molecular biology of bacterial respiration, fermentation, bioremediation. Microbiology, Biotechnology, Cell and Molecular Biology.

Cynthia Stewart, Research Assistant Professor. B.S., University of Delaware; PhD, Rutgers University. High pressure and other nonthermal technologies, such as cold pasteurization or commercial sterilization processes, to improve the quality and safety of foods. Microbiology, Biotechnology.

Jason Wan, Research Professor. B.S., Hunan University; M.S., Northeast Agricultural University; Ph.D., Deakin University (Australia). Molecular mechanisms of tracking foodborne pathogens, non-thermal food processing technologies. Microbiology, Biotechnology.

Dale A. Webster, Emeritus and Research Professor. B.S., University of Michigan; Ph.D., University of California, Berkeley. Biochemistry and molecular biology of bacterial respiration, biotechnology and bioremediation. Biochemistry, Microbiology, Biotechnology.

Jialing Xiang, Associate Professor. M.D., Xuzhou Medical College; Ph.D. University of Alabama, Birmingham. Molecular mechanisms of cancer and cancer gene therapy. Cell and Molecular Biology.

Chunbo Zhang, Assistant Professor. B.S., Ningbo Univeristy; Ph.D., University of Manitoba (Canada). Use of molecular genetics, biophysics, immunohistochemistry, pharmacology, and behavior to study olfactory transduction in the mouse and in fish. Cell and Molecular Biology.

Wei Zhang, Assistant Professor. B.S., Huazhong Agricultural University; Ph.D., Pennsylvania State University. Molecular detection, genotyping, epidemiology, virulence and pathogenesis of foodborne bacteria. Microbiology, Biotechnology.

Chemistry Faculty

Sandra Whaley Bishnoi, Assistant Professor. B.S., Ph.D., University of Texas at Austin. Synthesis and analysis of inorganic nanoparticles, biomolecular recognition, surface science, analytical chemistry, nanobiotechnology, development of nanoparticle delivery methods, and surface enhanced Raman scattering.

Brant Cage, Assistant Professor. B.S., University of West Florida; Ph.D., Florida State University. Synthesis and biophysical applications of magnetic materials, design and building sensitive instrumental techniques to characterize magnetic materials; theoretical analysis of novel materials with superior properties for particular needs, such as magnetic resonance imaging (MRI) enhancement, magnetic refrigeration, and standards for MRI.

Hyun-soon Chong, Associate Professor. B.S., M.S. Kyung Hee University; Ph.D. University of North Texas. Synthetic and mechanistic organic chemistry, macrocyclic chemistry, cancer therapeutics and diagnostics, medicinal chemistry, bioorganic and bioinorganic chemistry, biologically active synthetic and natural products, heterocyclic chemistry, molecular recognition studies, nanobiotechnology.

Walter C. Eisenberg, Emeritus Professor. B.S. University of Toronto (Canada); M.S., Rochester Institute of Technology; Ph.D., University of Buffalo. Organic-, oxidantand single oxygen chemistry, biochemistry, air pollution, polycyclic aromatic hydrocarbon transformation, analytical methods development, professional graduate education.

Robert Filler, Emeritus Professor, Senior Research Fellow. B.S., City College of New York; Ph.D., University of Iowa. Heterocyclic compounds, effects of fluorine in fluorine-containing compounds.

Adam S. Hock, Assistant Professor. B.S., University of Delaware, Ph.D., Massachusettes Institute of Technology. Homogenous and heterogenous inorganic and organometallic synthesis and catalysis; rational and tunable methods for the preparation of light-harvesting and novel electronic materials; structure, bonding, and electronic properties of molecular and extended materials.

Peter Y. Johnson, Professor. B.S., University of Illinois, Urbana-Champaign; Ph.D., Massachusetts Institute of Technology. Syntheses of penicillin related compounds; photochemical and/or transannular reactions.

M. Ishaque Khan, Professor, Associate Dean, College of Science and Letters, and Director of the Materials and Chemical Synthesis Program. Ph.D., Indian Institute of Technology (Kampur, India). Design, synthesis, and property studies of new generation, high performance advanced materials. Current focus is on nanomaterials for applications in chemical sensing, energy storage, and biomedical usage, and nanostructured catalysts doe detection and removal of toxic gases from industrual exhaust and flue gas streams, selective oxidation, (hydrocarbon's transformation into useful industrial feed-stocks), and hydrotreating catalysis.

Peter Lykos, Professor. B.S., Northwestern University; Ph.D., Carnegie Institute of Technology. Physical chemistry, standards for undergraduate chemistry and chemistry curricula, combination theoretical (Hartree Fock) and experimental (synchrotron radiation) determination of correlation energy, semi-empirical methods in quantum chemistry, computer applications in chemistry.

Braja K. Mandal, Professor. B.Sc., University of Calucutta (India); M.Sc., M.Tech., Ph.D., Indian Institute of Technology (India). Polymer science and engineering, electroactive materials, phthalocyanines and porphyrins, solid polymer electrolytes, lithium battery materials.

Diep Nguyen, Industry Professor, Director of the Professional Science Master Program in Analytical Chemistry, Ph.D., McGill University (Canada). Characterization of polymers, industrial applications of polymeric materials, analytical methods development and professional graduate education.

Kenneth Schug, Professor. B.S., Stanford University; Ph.D., University of Southern California. Chemical education, coordination compounds of transition metals emphasizing chemical reactivity of ligands, enhancement programs for K-12 teachers, minority medical students programs, research opportunities for high school students.

Joseph R. Stetter, Research Professor. B.S., Ph.D., State University of New York, Buffalo. Electroanalytical chemistry, environmental analytical chemistry, chemical sensors, detectors, development of new analytical methods.

Aditya K. Unni, Assistant Professor. B.S., Saint Olaf College; Ph.D., the University of Chicago. Synthesis of small molecule natural products with interesting structural characteristics and biological activities. Developing reactions, specifically in asymmetric catalysis, to access high value chemical building blocks for organic synthesis.

Sameer Varma, Research Assistant Professor. B.S., M.S., Indian Institute of Technology; Ph.D., University of Illinois, Urbana-Champaign. Computational chemistry, statistical mechanics, biohpysics, quantum mechanical simulations, molecular mechanics simulations, structural informatics, membrane-protein function, drug design.

Rong Wang, Associate Professor, Associate Chair. B.S., Julin University; Ph.D., University of Tokyo (Japan). Scanning probe microscopy, bioconjugate chemistry, biocompatible materials, method of development for single cell characterization and manipulation, analysis of effects of microenvironments on protein/cell/tissue function and dynamics.

Physics Faculty

Russell Betts, Professor and Dean of the College of Sciences and Letters. B.A., M.A., Oxford University; M.S., University of Pennsylvania; Ph.D., University of Pennsylvania. Nuclear Physics.

Grant Bunker, Professor and Associate Chair. B.A., Evergreen State College; Ph.D., University of Washington. X-ray absorption spectroscopy, biophysics, synchrotron radiation research, computational physics/chemistry.

Ray A. Burnstein, Emeritus and Research Professor. B.S., University of Chicago; M.S., University of Washington; Ph.D., University of Michigan. Experimental elementary particle physics, interactive teaching and technology. Liam Coffey, Associate Professor. B.A., Trinity College (Ireland). Ph.D., University of Chicago. Condensed matter theory.

Thomas Erber, Distinguished Emeritus Professor. B.S., Massachusetts Institute of Technology; M.S., Ph.D., University of Chicago. Electrodynamics, magnetism, fatigue, complex systems.

Laurence Friedman, Senior Lecturer and co-Director of the Health Physics program. B.S., University of Wisconsin; Ph.D. Rensselaer Polytechnic Institute. Health Physics, regulatory affairs.

David Gidalevitz, Assistant Professor of Physics. B.S., Urals Technical University (Russia); Ph.D., Weizmann Institute of Science (Israel). Membrane biophysics, biomaterials, drug delivery, biosensors and biomimetic thin films, and polymer films.

Alan Glodowski, Senior Lecturer of Physics. B.S., University of Wisconsin-Madison; M.S., Creighton University.

Porter W. Johnson, Emeritus Professor. B.S., Case Institute of Technology; M.A., Ph.D., Princeton University. Elementary particle theory, science education.

Daniel Kaplan, Professor and Director of the Center for Accelerator and Particle Physics. B.A., Haverford College; Ph.D., State University of New York, Stony Brook. Experimental high-energy physics, especially symmetry violation and rare decays of hyperons and charm and beauty hadrons, electronics for high-speed triggering and data acquisition.

Gocha Khelashvili, Assistant Research Professor of Physics. B.S., Tblisi State University; M.S., Johns Hopkins University; Ph.D., Illinois Institute of Technology. Medical and Health Physics.

Leon Lederman, Pritzker Professor of Physics, 1988 Nobel Laureate in Physics; Fermilab Director Emeritus. B.A., City College of New York; Ph.D., Columbia University. Experimental elementary particle physics.

Timothy Morrison, Professor, Director of the Center for Synchrotron Radiation Research and Instrumentation. B.A., Western Michigan University; Ph.D., University of Illinois, Urbana-Champaign. Solid-state physics, catalysts, x-ray absorption, x-ray optics.

Howard A. Rubin, Professor Emeritus. B.S., Massachusetts Institute of Technology; Ph.D., University of Maryland. Experimental elementary particle physics.

H. Larry Scott, Professor of Physics. B.S., Purdue University; Ph.D., Purdue University. Theoretical modeling and computer simulation of lipid bilayers and model biological membranes.

Carlo U. Segre, Professor, Associate Dean for Graduate Enrollment, and Associate Director of the Materials Research Collaborative Access Team. B.S. in Physics, B.S. in Chemistry, University of Illinois, Urbana-Champaign; M.S., Ph.D., University of California, San Diego. Experimental condensed-matter physics, superconductivity, x-ray structural studies of complex materials.

Harold N. Spector, Emeritus Professor. B.A., M.S., Ph.D., University of Chicago. Solid-state theory, electronic and optical processes and semi-conducting nanostructures.

Linda Klamp Spentzouris, Associate Professor. B.A., Colorado College; Ph.D., Northwestern University. Accelerator physics.

Zack Sullivan, Assistant Professor. B.A., Physics and Mathematics, Johns Hopkins University; M.S., Physics, University of Illinois at Urbana-Champaign; Ph.D., Physics, University of Illinois at Urbana-Champaign. Theoretical Particle Physics beyond the Standard Model.

Jeff Terry, Assistant Professor. B.S., University of Chicago; Ph.D., Stanford University. Synchroton radiation techniques.

Yagmur Torun, Assistant Professor. B.S., Middle East Technical University; Ph.D., SUNY at Stony Brook. Accelerator and High Energy Physics.

Christopher White, Associate Professor. B.S., University of Illinois, Urbana-Champaign; Ph.D., University of Minnesota. Experimental elementary particle physics.

John Zasadzinski, Professor. B.S., Illinois Benedictine College; Ph.D., Iowa State University. Solid state physics.

Earl Zwicker, Emeritus Professor of Physics. B.S., University of Wisconsin; Ph.D., Illinois Institute of Technology. Physics education.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0
TOEFL minimum: 550/213/80*

The Graduate Record Examination (GRE) is required for all applicants. The GRE minimum scores are:

Ph.D.: 1200 (quantitative + verbal),
3.0 (analytical writing)
M.S.: 1000 (quantitative + verbal),
2.5 (analytical writing)
MAS: 1000 (quantitative + verbal),
2.5 (analytical writing)
MCH: 900 (quantitative + verbal),
2.5 (analytical writing)

Applicants to the doctoral program in chemistry are strongly encouraged to submit the subject-area GRE score (Subject No. 27). Applicants to the doctoral program in physics are strongly encouraged, but not required, to take the subject-area GRE exam in physics. Applicants to the doctoral program in molecular biochemistry and biophysics are strongly encouraged to take one of the subject exams in biology, molecular biology, chemistry or physics.

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered.

Applicants to one of the department's programs (Biology, Chemistry, Physics or Molecular Biochemistry and Biophysics) are expected to have a bachelors degree from an accredited institution with a major in that same discipline, or a closely allied major with additional coursework that prepares the student for graduate study in the chosen program. Students who have not completed all required courses may be accepted for general admission and can begin coursework, but must remove any deficiencies before the MCH, MAS, and M.S. comprehensive/Ph.D. qualifying examination.

* Paper-based/computer-based/internet-based test score.

Departmental Graduate Examinations

All full-time students in the M.S. and Ph.D. programs are required to take and pass the written M.S. comprehensive/Ph.D. qualifying examination by the end of their fourth semester of study. Part-time students must pass this examination by a comparable stage of their programs. The examination is offered twice each academic year. A student may sit officially for the examination a maximum of two times. Students passing this examination at the Ph.D. level are judged to be qualified to continue in the Ph.D. program. Students passing at the Master of Science level or above may obtain their masters degree after completing the requirements described in the following sections. All students in the Ph.D. program who have passed the written qualifying examination must take and pass a comprehensive examination before the end of the sixth semester of full-time study. Part-time students must pass this examination by a comparable stage of their programs. This examination consists of a written proposal, an oral presentation and a defense of the proposal before a faculty committee. A student may take this examination a maximum of two times. Students passing this examination may continue with their research and will receive a Ph.D. upon satisfactory completion of all other required courses and general requirements of the Graduate College, a written dissertation and final oral thesis defense.

All students in the professional master degree programs are required to take and pass a comprehensive exam. Students may sit for the exam a limited number of times, depending upon the individual program.

Biology

The department offers graduate programs leading to Master of Biology and to M.S. and Ph.D. degrees in biology, concentrating educational and research activities in the areas of biochemistry, biotechnology, cell and molecular biology, and microbiology. Graduate education in biology is available on either a full- or a part-time basis. Masters degree programs are designed so that they may be completed by part-time students. Doctoral-level courses are usually available either in the evenings. on Saturdays, or on the internet. Each new graduate student is assigned a graduate student advisor and must obtain the approval of the advisor each semester before registering for any graduate classes.

Master of Biology

Minimum 30 credit hours
Comprehensive examination

The Master of Biology is a course-only, professional masters degree program designed for professionals who seek advanced and specialized study in the field without the requirement of a thesis or project.

This program is also available on the Web, and at televised viewing sites throughout the Chicago area. Students should consult www.iit-online.iit.edu for more information.

Students must pass the written comprehensive examination (see Departmental Graduate Examinations) in their respective areas of specialization: biochemistry, cell and molecular biology, or microbiology. Students in biotechnology may choose any of the three examinations. The program consists of a minimum of 30 credit hours of coursework as follows.

Cell and Molecular Biology

BIOL 401 Introductory Biochemistry **AND**
BIOL 402 Metabolic Biochemistry
OR
BIOL 504 Biochemistry Lectures
BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 515 Molecular Biology
BIOL 526 Developmental Biology

AND 6-9 hours of approved electives

Microbiology

BIOL 401 Introductory Biochemistry **AND**
BIOL 402 Metabolic Biochemistry
OR
BIOL 504 Biochemistry Lectures
BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 515 Molecular Biology
BIOL 542 Advanced Microbiology

AND 6-9 hours of approved electives

Biochemistry

BIOL 401 Introductory Biochemistry **AND**
BIOL 402 Metabolic Biochemistry
OR
BIOL 504 Biochemistry Lectures
BIOL 512 Advanced Biochemistry
BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 515 Molecular Biology

AND 6-9 hours of approved electives

Biotechnology

BIOL 401 Introductory Biochemistry **AND**
BIOL 402 Metabolic Biochemistry
OR
BIOL 504 Biochemistry Lectures
BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 515 Molecular Biology
BIOL 562 Functional Genomics

AND 6-9 hours of approved electives

Students in each area of specialization also take the following three courses:

CHEM 513 Statistics for Analytical Chemists
COM 423 Communication in the Workplace **OR**
COM 421 Technical Communications **OR**
COM 580 Communicating Sciences
AND
BIOL 511 Project Management **OR**
CHEM 524 Synthesis and Intellectual Property **OR**
INTM 511 Industrial Leadership

Elective courses for the areas of specialization will be chosen in conjunction with the student's advisor.

Master of Science in Biology

Minimum 32 credit hours
Comprehensive examination
Option 1: Thesis
Option 2: Library or Laboratory research project

A Master of Science student must complete 32-34 credit hours of approved graduate work in one of the areas of specialization detailed below. This will include 26-30 credit hours of coursework and one credit hour of BIOL 595 Colloquium. Two options are available to complete the M.S. degree requirements: a thesis option and a nonthesis option.

Students must pass the written M.S. comprehensive examination (see Departmental Graduate Examinations) in their respective areas of specialization: biochemistry, cell and molecular biology, or microbiology. Students in biotechnology may choose any of the three examinations.

Thesis Option

The thesis option is designed for individuals planning careers as experimental biologists, including those who may wish to pursue a Ph.D. This option is available on a competitive basis. Students choosing the thesis option must complete six credit hours of thesis research (BIOL 591). Students must also prepare a written thesis based on laboratory research.

Non-Thesis Option

The non-thesis option is intended as a degree to meet the needs of teachers, science administrators, policy makers in the life sciences, patent attorneys and others.

Students who elect the non-thesis option must complete a library research project in one of the following courses: BIOL 572 (Literature in Biochemistry), BIOL 574 (Literature in Biotechnology), BIOL 576 (Literature in Cell and Molecular Biology), or BIOL 578 (Literature in Microbiology); or a laboratory research project in BIOL 522 (Research Techniques in the Biological Sciences) plus BIOL 597 (special topics).

Master of Science in Biology with specialization in Biochemistry

32 credit hours

Required courses (19 hours)

BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 504 Biochemistry Lectures
BIOL 512 Advanced Biochemistry
BIOL 515 Molecular Biology
BIOL 519 Biochemistry Laboratory
BIOL 555 Macromolecular Structure Determination

Additional requirements (7 hours):

BIOL 595 Colloquium
BIOL 591 Research
OR
CHEM 591 Research
OR
BIOL 572 Literature in Biochemistry **AND** one additional elective
OR
BIOL 522 Research Techniques in Biological Sciences
AND
BIOL 597 Special Topics

Elective courses (6 hours)

BIOL 410 Medical Microbiology
BIOL 426 Cancer Biology
BIOL 430 Animal Physiology
BIOL 503 Virology
BIOL 514 Toxicology
BIOL 520 Advanced Biochemistry Laboratory
BIOL 526 Developmental Biology
BIOL 527 Immunology and Immunochemistry
BIOL 533 Laboratory in Cell and Molecular Biology
BIOL 539 Advanced Cell Biology Laboratory
BIOL 542 Advanced Microbiology
BIOL 545 Advanced Cell Biology
BIOL 550 Bioinformatics and Biotechnology
BIOL 562 Functional Genomics

Other requirements are identical to those described previously for all M.S. students in biology. The requirements for admission to this program include one year of physical chemistry in addition to the usual requirements for admission to graduate study in biology.

Master of Science in Biology with specialization in Biotechnology

Minimum 32 credit hours

Required Courses (19 hours minimum)

BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 504 Biochemistry Lectures
OR
BIOL 401 Introductory Biochemistry
AND
BIOL 402 Metabolic Biochemistry

BIOL 515 Molecular Biology
BIOL 519 Biochemistry Laboratory
OR
BIOL 533 Laboratory in Cell and Molecular Biology
BIOL 550 Bioinformatics and Biotechnology
BIOL 562 Functional Genomics

Additional requirements (7 hours):

BIOL 595 Colloquium
BIOL 591 Research
OR
BIOL 574 Literature in Biotechnology **AND** one addtional elective
OR
BIOL 522 Research Techniques in Biological Sciences
AND
BIOL 597 Special Topics

Elective courses (6 hours)

BIOL 410 Medical Microbiology
BIOL 426 Cancer Biology
BIOL 430 Animal Physiology
BIOL 503 Virology
BIOL 512 Advanced Biochemistry
BIOL 514 Toxicology
BIOL 520 Advanced Biochemistry Laboratory
BIOL 521 Advanced Micro Genetics Laboratory
BIOL 526 Developmental Biology
BIOL 527 Immunology and Immunochemistry
BIOL 539 Advanced Cell Biology Laboratory
BIOL 542 Advanced Microbiology
BIOL 545 Advanced Cell Biology
BIOL 555 Macromolecular Structure Determination
BIOL 580 Laboratory Rotation in Molecular Biochemistry and Biophysics

Other requirements are identical to those described previously for all M.S. students in biology.

Master of Science in Biology with specialization in Cell and Molecular Biology

Minimum 32 credit hours

Required Courses (19 hours minimum)

BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 504 Biochemistry Lectures
OR
BIOL 401 Introductory Biochemistry
AND
BIOL 402 Metabolic Biochemistry

BIOL 515 Molecular Biology
BIOL 526 Developmental Biology
BIOL 533 Laboratory in Cell and Molecular Biology
BIOL 545 Advanced Cell Biology

Additional requirements (7 hours):

BIOL 595 Colloquium
BIOL 591 Research
OR
BIOL 576 Literature in Cell Biology **AND** one additional elective
OR
BIOL 522 Research Techniques in Biological Sciences
AND
BIOL 597 Special Topics

Elective courses (6 hours)

BIOL 410 Medical Microbiology
BIOL 426 Cancer Biology
BIOL 430 Animal Physiology
BIOL 503 Virology
BIOL 512 Advanced Biochemistry
BIOL 514 Toxicology
BIOL 519 Biochemistry Laboratory
BIOL 520 Advanced Biochemistry Laboratory
BIOL 527 Immunology and Immunochemistry
BIOL 539 Advanced Cell Biology Laboratory
BIOL 542 Advanced Microbiology
BIOL 550 Bioinformatics and Biotechnology
BIOL 555 Macromolecular Structure Determination
BIOL 562 Functional Genomics
BIOL 580 Laboratory Rotation in Molecular Biochemistry and Biophysics

Other requirements are identical to those described previously for all M.S. students in biology.

Master of Science in Biology with specialization in Microbiology

Minimum 32 credit hours

Required Courses (22 hours minimum)

BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 503 Virology
BIOL 504 Biochemistry Lectures **OR**
BIOL 401 Introductory Biochemistry
AND
BIOL 402 Metabolic Biochemistry

BIOL 515 Molecular Biology
BIOL 519 Biochemistry Laboratory
OR
BIOL 533 Laboratory in Cell and Molecular Biology
BIOL 542 Advanced Microbiology
BIOL 562 Functional Genomics

Additional requirements (7 hours):

BIOL 595 Colloquium
BIOL 591 Research
OR
BIOL 578 Literature in Microbiology **AND** one additional elective
OR
BIOL 522 Research Techniques in Biological Sciences
AND
BIOL 597 Special Topics

Elective courses (3 hours)

BIOL 410 Medical Microbiology
BIOL 426 Cancer Biology
BIOL 430 Animal Physiology
BIOL 512 Advanced Biochemistry
BIOL 514 Toxicology
BIOL 520 Advanced Biochemistry Laboratory
BIOL 521 Advanced Micro Genetics Laboratory
BIOL 526 Developmental Biology
BIOL 527 Immunology and Immunochemistry
BIOL 539 Advanced Cell Biology Laboratory
BIOL 545 Advanced Cell Biology
BIOL 550 Bioinformatics and Biotechnology
BIOL 555 Macromolecular Structure Determination
BIOL 580 Laboratory Rotation in Molecular Biochemistry and Biophysics

Other requirements are identical to those described previously for all M.S. students in biology.

Doctor of Philosophy in Biology

84 credit hours
Written qualifying examination
Comprehensive examination
Dissertation and oral defense

A minimum of 84 credit hours is required for the Ph.D. degree in biology. Students should consult the section Transfer Credits on page 31 for rules on how many credit hours may be transferred from another institution. Completion of an M.S. degree is not normally required for admission to the full-time program for the Ph.D. degree but may be required of part-time students. Students must pass the Ph.D. qualifying examination in their respective areas of specialization: biochemistry, cell and molecular biology, or microbiology (see Departmental Graduation Examinations).

Each student, in addition, will be required to pass a comprehensive examination taken prior to performing the major portion of the dissertation research, and in any event, prior to the sixth semester of study and at least one year before oral defense of the thesis. The final examination for the Ph.D. degree consists of an oral presentation and defense of the dissertation.

The Ph.D. program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the program of study (Form 401). Programs of study may be designed in any of the three areas of concentration. However, all programs of study must include at least 36 credit hours in formal courses (exclusive of BIOL 591 and BIOL 691).

Formal courses must include the core courses listed below:

Core Courses

BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 504 Biochemistry Lectures
BIOL 515 Molecular Biology
BIOL 595 Biology Colloquium (4 times)

Elective Courses

BIOL 410 Medical Microbiology
BIOL 414 Genetics for Engineering Sciences
BIOL 426 Cancer Biology
BIOL 430 Animal Physiology
BIOL 503 Virology
BIOL 514 Toxicology
BIOL 519 Biochemistry Laboratory
BIOL 520 Advanced Biochemistry Laboratory
BIOL 521 Advanced Micro Genetics Laboratory
BIOL 526 Developmental Biology
BIOL 527 Immunology and Immunochemistry
BIOL 533 Laboratory in Cell and Molecular Biology
BIOL 539 Advanced Cell Biology Laboratory
BIOL 542 Advanced Microbiology
BIOL 545 Advanced Cell Biology
BIOL 550 Bioinformatics and Biotechnology
BIOL 555 Macromolecular Structure Determination
BIOL 562 Functional Genomics
BIOL 580 Laboratory Rotation in Molecular Biochemistry and Biophysics
BIOL 584 Graduate Seminar in Biology
BIOL 597 Special Topics
PHYS 410 Molecular Biophysics

All research for the dissertation must be carried out under the direct supervision of a faculty research advisor. The faculty research advisor will also act as the candidate's academic advisor. Students must have passed the written qualifying examination before registering for BIOL 691 (Ph.D. Thesis Research). Students may complete all formal course requirements for the Ph.D. degree as either full-time or part-time students.

Molecular Biochemistry and Biophysics (MBB)

The department offers interdisciplinary programs leading to M.S. and Ph.D. degrees in molecular biochemistry and biophysics. New advances in our understanding of biological function can be expected from a synthesis of molecular genetics, biochemistry and insights gained from molecular structural information. Individuals with a quantitative, physical approach will be best placed to be innovators in the field. MBB programs complement more traditional graduate programs in biology, chemistry and physics by offering an integrated, molecular-based approach to understanding biological problems, taking insights from all three disciplines.

A major focus of the program is on biophysical approaches to determining the structure of macromolecules and macromolecular assemblies. Faculty advisors are chosen from any of the participating departmental faculty regardless of their affiliation to a particular discipline; a particular strength of the participating faculty is in exploiting synchrotron x-ray sources for biological structural studies. MBB students will have access to state-of-the-art x-ray facilities at the nearby Advanced Photon Source, currently one of the most intense x-ray sources in the world.

Master of Science in Molecular Biochemistry and Biophysics

32 credit hours
Comprehensive examination
Option 1: Thesis
Option 2: Library or Laboratory research project

A master's student must complete 32 credit hours of approved graduate work, including a core of 22 credit hours, 1 hour of BIOL 595 (Colloquium), 3 credit hours of approved electives, and 6 credit hours of research toward the thesis (BIOL, CHEM, or PHYS 591); or BIOL 572 (Literature in Biochemistry) and one additional elective, or BIOL 522 (Research Techniques in the Biological Sciences), and 3 credit hours of BIOL 597 (Special Topics).

Required Courses (22 hours)

BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 504 Biochemistry Lectures
BIOL 515 Molecular Biology
BIOL 519 Biochemistry Laboratory
OR
BIOL 533 Laboratory in Cell and Molecular Biology
BIOL 555 Macromolecular Structure Determination
PHYS 410 Biophysics
BIOL 512 Advanced Biochemistry Lectures

Additional requirements (7 hours):

BIOL 595 Colloquium
BIOL 591 Research
OR
CHEM 591 Research
OR
PHYS 591 Research
OR
BIOL 572 Literature in Biochemistry **AND** one addtional elective
OR
BIOL 522 Research Techniques in Biological Sciences
AND
BIOL 597 Special Topics

Elective courses (3 hours)

BIOL 410 Medical Microbiology
BIOL 426 Cancer Biology
BIOL 430 Animal Physiology
BIOL 503 Virology
BIOL 514 Toxicology
BIOL 520 Advanced Biochemistry Laboratory
BIOL 526 Developmental Biology
BIOL 527 Immunology and Immunochemistry
BIOL 539 Advanced Cell Biology Laboratory
BIOL 542 Advanced Microbiology
BIOL 545 Advanced Cell Biology
BIOL 550 Bioinformatics and Biotechnology
BIOL 562 Functional Genomics
BIOL 580 Laboratory Rotation in Molecular Biochemistry and Biophysics

The elective is chosen in consultation with an academic advisor. Research for the dissertation must be carried out under the direct supervision of a participating faculty member; the faculty reseach advisor also acts as the candidate's academic advisor.

Thesis Option

The thesis option is designed for individuals planning careers as experimental biologists, including those who may wish to pursue a Ph.D. This option is available on a competitive basis. Students choosing the thesis option must complete six credit hours of thesis research (BIOL, CHEM, or PHYS 591). Students must also prepare a written thesis based on laboratory research.

Non-Thesis Option

The non-thesis option is intended as a degree to meet the needs of teachers, science administrators, policy makers in the life sciences, patent attorneys and others.
Students who elect the non-thesis option must complete a library research project in BIOL 572 (Literature in Biochemistry), or a laboratory based research project in BIOL 522 (Research Techniques in the Biological Sciences) plus BIOL 597 (Special Topics).

Doctor of Philosophy in Molecular Biochemistry and Biophysics

84 credit hours
Written qualifying examination
Comprehensive examination
Dissertation and oral defense

A minimum of 84 credit hours of instruction is required for the MBB Ph.D. Students should consult the section Transfer Credits on page 31 for rules on how many credit hours may be transferred from another institution. Completion of an M.S. degree is not normally required for admission to the Ph.D. program. Students must complete 21 credit hours of core courses and at least five additional courses from the list of electives.

Each graduate student must take and pass the written Ph.D. qualifying examination in order to enter into candidacy for the doctorate. Each student, in addition, will be required to pass a comprehensive examination taken prior to performing the major portion of the dissertation research, and in any event, prior to the sixth semester of study and at least one year before oral defense of the thesis. The final examination for the Ph.D. degree consists of an oral presentation and defense of the dissertation.

The Ph.D. program is tailored to fit the students background and goals and is subject to approval at the time of filing of the program of study (Form 401). The program of study must include at least 36 credt hours in formal courses (exclusive of BIOL 591 and BIOL 691).

All students will be required to take the following courses, or have equivalent background:

Core courses

BIOL 445 Cell Biology
OR
BIOL 544 Molecular Biology of Cells
BIOL 504 Biochemistry Lectures
BIOL 512 Advanced Biochemistry
BIOL 515 Molecular Biology
BIOL 555 Macromolecular Structure Determination
BIOL 584 Graduate Seminar in Biology
BIOL 595 Biology Colloquium
PHYS 410 Molecular Biophysics

MBB students, in consultation with their academic advisor, choose the remainder of their formal coursework from the following list of elective courses:

Elective Courses

BIOL 410 Medical Microbiology
BIOL 414 Genetics for Engineering Sciences
BIOL 426 Cancer Biology
BIOL 430 Animal Physiology
BIOL 503 Virology
BIOL 514 Toxicology
BIOL 519 Biochemistry Laboratory
BIOL 520 Advanced Biochemistry Laboratory
BIOL 521 Advanced Micro Genetics Laboratory
BIOL 526 Developmental Biology
BIOL 527 Immunology and Immunochemistry
BIOL 533 Laboratory in Cell and Molecular Biology
BIOL 539 Advanced Cell Biology Laboratory
BIOL 542 Advanced Microbiology
BIOL 545 Advanced Cell Biology
BIOL 550 Bioinformatics and Biotechnology
BIOL 562 Functional Genomics
BIOL 580 Laboratory Rotation in Molecular Biochemistry and Biophysics
BIOL 597 Special Topics

Other courses may be prescribed by the advisor/thesis committee according to the student's individual needs for the program of study. All research for the dissertation must be carried out under the direct supervision of a faculty research advisor who will also act as the candidate's academic advisor.

Chemistry

The department offers graduate programs leading to M.S. and Ph.D. degrees in chemistry. Each student's program is planned individually to meet individual needs, interests and capabilities. In addition, the department offers two professional master's programs designed for the parttime student and available through distance learning. The aim of these programs is to develop chemists who are able to think creatively and critically. In recognition of the value of teaching experience in strengthening an individual's understanding of his or her field of study and as an aid in making career decisions, the department requires all full-time Ph.D. students to participate in instructional activities.

Each new graduate student is assigned a graduate student advisor and must obtain the approval of the advisor each semester before registering for any graduate classes.

Master of Chemistry in Analytical Chemistry

32 credit hours
Comprehensive examination

The professional master's program in analytical chemistry is a part-time program for working chemists seeking to strengthen their understanding of analytical chemistry. The specific goal of the program is to provide the student with a broad and in-depth understanding of state-of-the-art analytical techniques with a firm grounding in separation science, spectroscopy, method development and sample preparation. In addition, students acquire professional skills in effective communication, statistics, and business principles. Candidates must possess a bachelor's degree (ideally in science or engineering) with at least one semester of calculus, one semester of calculus-based physical chemistry, one semester of analytical chemistry, and two semesters of organic chemistry. Candidates' advisors assist them in determining if any further prerequisites are necessary. A final comprehensive exam is required for graduation. This program is also available via the internet. Students should consult www.iit.edu/csl/bcps for more information.

Core Courses

CHEM 500 Advanced Analytical Chemistry
CHEM 505 Spectroscopic Methods I
CHEM 506 Sampling and Sample Preparation
CHEM 508 Analytical Methods Development
CHEM 509 Physical Methods of Characterization
CHEM 512 Spectroscopic Methods II
CHEM 513 Statistics for Analytical Chemists
CHEM 515 Fundamentals of Separation Science
CHEM 516 Applied Liquid and Gas Chromatography

Choose one of the following three courses:

CHEM 542 Polymer Characterization and Analysis
CHEM 543 Analytical Chemistry in Pharmaceutical Laboratories
CHEM 544 Colloids and Colloid Analysis

Choose two of the following courses:

CHEM 511 Project Management
COM 423 Communication in the Workplace
OR
COM 580 Communicating Science
INTM 511 Industrial Leadership

Master of Chemistry

32 credit hours
Comprehensive examination

A minimum of 32 credit hours is required for the Master of Chemistry degree. Students seeking the Master of Chemistry degree must pass the oral comprehensive examination in their area of specialization (as determined by the student's academic advisor) by the end of their 4th semester in the master of chemistry degree program. The comprehensive examinations are given in the following areas:

- Analytical Chemistry
- Biochemistry
- Inorganic Chemistry
- Organic Chemistry
- Polymer Chemistry
- Physical chemistry

The Master of Chemistry program is tailored to fit the student's background and goal and is subject to approval at the time of filing of the Program of Study (Form 401). Programs of study must include the following core courses.

CHEM 584 Graduate Seminar
CHEM 585 Colloquium in Chemistry

The required coursework includes a minimum of four core courses chosen from the following core courses (credit hours in parentheses). Each of the four core courses must be chosen from six different chemistry disciplines including analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry, and polymer chemistry.

CHEM 455 Advanced Organic Chemistry
OR
CHEM 530 Organic Reactions and Mechanisms
CHEM 500 Advanced Analytical Chemistry
OR
CHEM 505 Spectroscopic Methods I
CHEM 520 Advanced Inorganic Chemistry
OR
CHEM 521 Structural Inorganic and Solid-State Chemistry
CHEM 550 Quantum Chemistry
CHEM 470 Introduction to Polymer Chemistry
OR
CHEM 535 Polymer Synthesis
BIOL 504 Biochemistry Lectures

There are 15 course credit hours total required by the chemistry program. The graduate college requires 20 course credit hours. The remainder of the program of study will be chosen in consultation with the student's advisor. Students can choose any of the elective courses in consultation with their academic advisor.

Master of Chemistry in Materials and Chemical Synthesis

31 credit hours
Comprehensive examination

The professional masters program in materials and chemical synthesis is a part-time program designed for scientists who wish to broaden their background in synthesis and characterization of materials and chemical systems. The program combines modern materials design and synthesis strategies with innovative characterization techniques, computational & simulation methods, environmental regulations, project management, technical communication, and intellectual property management. The specific goals of the program of study are to provide the student with a broad and in-depth understanding of state-of the-art in materials and chemical synthesis and characterization techniques; to learn how to design and manage projects; to sharpen intellectual property management techniques; to learn how to operate under regulatory constraints; and to improve communication skills. Candidates must have a bachelors degree (ideally in science or engineering), with at least two semesters of organic chemistry and two semesters of calculus. Academic advisor assists students in determining whether any prerequisites are necessary. A final comprehensive examination is required for graduation. This program is also available on the Web, and at televised viewing sites throughout the Chicago area. Students should consult www.iit.edu/csl/bcps for more information.

Core Courses

CHEM 454 Computer Modeling and Simulations
CHEM 505 Spectroscopic Methods I
CHEM 511 Project Management
CHEM 521 Structural, Inorganic, and Materials Chemistry
CHEM 522 Efficient Synthesis and Catalytic Chemistry
CHEM 524 Synthesis and Intellectual Property Management
CHEM 530 Organic Reaction Mechanisms
CHEM 535 Polymer Synthesis
CHEM 539 Introduction to Pharmaceutical Chemistry
ENVE 545 Environmental Regulations and Risk Assessment
COM 423 Communication in the Workplace

Master of Science in Chemistry

32 credit hours
Comprehensive examination
Thesis and oral defense

A minimum of 32 credit hours is required for the M.S. in chemistry. Students seeking the Master of Science degree must pass the written comprehensive examination in their area of specialization (as determined by the student's thesis advisor) by the end of their fourth semester in the M.S. program. The comprehensive examinations are given in the following areas:

- Analytical Chemistry
- Biochemistry
- Inorganic Chemistry
- Organic Chemistry
- Physical Chemistry
- Polymer Chemistry

The student must also write a thesis based on original research and defend it before his or her M.S. thesis committee. The thesis and oral defense should be completed before the end of their 3rd year.

The M.S. program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the Program of Study (Form 401).

Required Courses

CHEM 584 Graduate Seminar
CHEM 585 Colloquium in Chemistry

The required coursework includes a minimum of four core courses chosen from the following courses (credit hours in parentheses). Each of the four core courses must be chosen from six different chemistry disciplines including analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry, and polymer chemistry.

CHEM 455 Advanced Organic Chemistry
OR
CHEM 530 Organic Reactions and Mechanisms
CHEM 500 Advanced Analytical Chemistry
OR
CHEM 505 Spectroscopic Methods
CHEM 520 Advanced Inorganic Chemistry
OR
CHEM 521 Structural Inorganic and Solid-State Chemistry
CHEM 550 Quantum Chemistry
CHEM 470 Introduction to Polymer Chemistry
OR
CHEM 535 Polymer Synthesis
BIOL 504 Biochemistry Lectures

There are 15 course credit hours total required by the chemistry program. The graduate college requires 20 course credit hours. The remainder of the program of study will be chosen in consultation with the student's advisor. Students can choose any of the elective courses in consultation with their academic advisor.

Doctor of Philosophy in Chemistry

84 credit hours
Written qualifying examination
Comprehensive examination
Dissertation and oral defense

A minimum of 84 credit hours is required for the Ph.D. in chemistry students who have received an M.S. degree from another university may petition for transfer of up to 32 credit hours applicable toward the Ph.D. degree. Students must pass the Ph.D. qualifying examination in their area of specialization (as determined by the student's thesis advisor) by the end of their fourth semester in the Ph.D. program. Ph.D. qualifying examinations are given in the following areas:

- Analytical Chemistry
- Biochemistry
- Inorganic Chemistry
- Organic Chemistry
- Physical Chemistry
- Polymer Chemistry

The comprehensive examination will be taken and passed on each students research progress and thesis proposal. A student must write a thesis proposal and present a research seminar on his or her thesis progress before their Ph.D. thesis committee. Students must pass the comprehensive exam before the end of their 3rd year. The final phase in the Ph.D. degree program is the successful oral defense of the dissertation and submission of a Ph.D. dissertation approved by the academic advisor and the thesis committee.

The Ph.D. program is tailored to fit the student's background and goal and is subject to approval at the time of filing of the Program of Study (Form 401).

Required Courses

CHEM 550 Chemical Bonding
CHEM 584 Graduate Seminar
CHEM 585 Colloquium in Chemistry
CHEM 684 Graduate Seminar
CHEM 685 Colloquium in Chemistry

The required coursework includes a minimum of four core courses chosen from the following courses. Each of the four core courses must be chosen from six different chemistry disciplines including analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry and polymer chemistry.

CHEM 455 Advanced Organic Chemistry
OR
CHEM 530 Organic Reaction Mechanisms
CHEM 500 Advanced Analytical Chemistry
OR
CHEM 505 Spectroscopic Methods I
CHEM 518 Electrochemical Methods
CHEM 520 Advanced Inorganic Chemistry
OR
CHEM 521 Structural Inorganic and Solid-State Chemistry
CHEM 550 Quantum Chemistry
CHEM 470 Introduction to Polymer Chemistry
OR
CHEM 535 Polymer Synthesis
BIOL 504 Biochemistry Lectures

Physics

The department offers programs leading to M.S. and Ph.D. degrees in physics. The M.S. degree is not a prerequisite for the Ph.D. The department also offers a professional masters program in health physics designed for the part-time student and available through distance learning. Research is organized into small groups of faculty members, post-doctoral associates, graduate students and undergraduate students working on closely related projects. The principal active areas include experimental and theoretical condensed matter physics, experimental and theoretical elementary particle physics, synchrotron radiation physics, accelerator physics, structural and computational biophysics, magnetism and electrodynamics. Classes are generally small and informal, and thesis research is carried out in close collaboration with the faculty adviser.

In recognition of the value of teaching experience in strengthening an individuals understanding of his or her field of study and as an aid in making career decisions, the department requires full-time students to participate in instructional activities. Each new graduate student is assigned a graduate student adviser and must obtain the approval of the adviser each semester before registering for any graduate classes.

Master of Health Physics

Minimum 30 credit hours
Comprehensive examination

Designed primarily for working professional health physicists in government, medicine, research and industry, this program combines technical depth with the interdisciplinary viewpoints of leadership, management and communications. The degree can be completed in four semesters and two summer sessions of part-time study. Applicants must have completed coursework in calculus through differential equations and a calculus-based general physics sequence. A course in modern physics, including some basic quantum mechanics, is strongly recommended.

This program is also available on the Web, and at televised viewing sites throughout the Chicago area. Students should consult www.iit-online.iit.edu for more information.

Required Courses

PHYS 561 Radiation Biophysics
PHYS 566 Radiation Health Physics
OR
PHYS 579 Therapeutic Medical Physics II
PHYS 571 Radiation Physics I
PHYS 572 Radiation Physics II
PHYS 573 Standards, Statutes, and Regulations
PHYS 576 External Dosimetry
PHYS 577 Internal Dosimetry
PHYS 578 Therapeutic Medical Physics I
PHYS 770 Instrumentation for Radiation Health Physics
COM 423 Communication in the Workplace
CHEM 513 Statistics for Analytical Chemists
INTM 511 Industrial Leadership
PHYS 568 Business Principles/Project Management

Master of Science in Physics

32 credit hours
Comprehensive examination
Thesis and oral defense

For those interested in research, seven to nine credit hours of PHYS 591 (Thesis Research) may be applied to the 32-credit-hour requirement. The basic program of coursework must include two semesters of PHYS 585 or PHYS 685 (Colloquium) and the M.S. core:

PHYS 501 Methods of Theoretical Physics I
PHYS 505 Electromagnetic Theory
PHYS 508 Analytical Dynamics
PHYS 509 Quantum Theory I

The remaining course requirements may be satisfied by additional graduate or advanced undergraduate electives.

Doctor of Philosophy in Physics

84 credit hours, approved by faculty adviser
Written qualifying examination
Comprehensive examination
Dissertation and oral defense, supervised by faculty member and approved by thesis committee

The requirements for the degree consist of a program of 84 credit hours approved by the faculty adviser; passing the Ph.D. qualifying and comprehensive examinations; and the completion of a research thesis supervised by a faculty member and approved by a thesis committee. Students should consult the section Transfer Credits in this bulletin for rules on how many credit hours may be transferred from another institution. The required coursework includes 4 semesters of PHYS 585 or PHYS 685 (Colloquium) and the graduate core:

PHYS 501 Methods of Theoretical Physics I
PHYS 505 Electromagnetic Theory
PHYS 508 Analytical Dynamics
PHYS 509 Quantum Theory I
PHYS 510 Quantum Theory II
PHYS 515 Statistical Mechanics

and at least three specialized or advanced physics graduate courses chosen from the following:

PHYS 502 Methods of Theoretical Physics II
PHYS 507 Electrodynamics
PHYS 510 Quantum Theory II
PHYS 533 Group Theory in Physics
PHYS 537 Physics of the Solid State I
PHYS 538 Physics of the Solid State II
PHYS 539 Physical Methods of Characterization
PHYS 545 Particle Physics I
PHYS 546 Particle Physics II
PHYS 553 Quantum Field Theory
PHYS 561 Radiation Biophysics
PHYS 570 Introduction to Synchrotron Radiation

The remaining course requirements may be satisfied by additional graduate or advanced undergraduate electives and research. Students are encouraged to participate in faculty research programs and seminars early in their graduate careers. Thesis work may follow from these activities. All research for the dissertation must be carried out under the direct supervision of a faculty research adviser. Students must have passed the written qualifying examination before registering for PHYS 691 (Ph.D. Thesis Research).

Certificate Programs

Analytical Method Development

Required courses

CHEM 506 Sampling and Sample Preparation
CHEM 508 Analytical Methods Development

AND two courses selected from the list of elect ives below.

Analytical Spectroscopy

Required Courses

CHEM 505 Spectroscopic Methods I
CHEM 512 Spectroscopic Methods II

AND two courses selected from the list of electives below.

Chromatography

Required Courses

CHEM 515 Fundamentals of Separation Science
CHEM 516 Applied Liquid and Gas Chromatography

AND two courses selected from the list of electives below.

Electives for Analytical Method Development, Analytical Spectroscopy and Chromatography

CHEM 500 Advanced Analytical Chemistry
CHEM 515 Fundamentals of Separation Science
CHEM 516 Applied Liquid and Gas Chromatography
CHEM 505 Spectroscopic Methods
CHEM 506 Sampling and Sample Preparation
CHEM 509 Physical Methods of Characterization
CHEM 512 Spectroscopic Methods II
CHEM 513 Statistics for Analytical Chemists
CHEM 542 Polymer Charicterization and Analysis
CHEM 543 Analytical Chemistry in Pharmaceutical Sciences
CHEM 544 Colloids and Colloid Analysis

Characterization of Inorganic and Organic Materials

Required Courses

CHEM 505 Spectroscopic Methods I
CHEM 509 Physical Methods of Characterization
CHEM 512 Spectroscopic Methods II

AND one course selected from the list of electives on the following page.

Synthesis and Characterization of Inorganic Materials

Required Courses

CHEM 505 Spectroscopic Methods I
CHEM 521 Structural, Inorganic and Materials Chemistry
CHEM 522 Efficient Synthesis and Catalytic Chemistry

AND one course selected from the list of electives on the following page.

Synthesis and Characterization of Organic Materials

Required Courses

CHEM 505 Spectroscopic Methods I
CHEM 531 Tactics in Organic Synthesis
CHEM 539 Introduction to Pharmaceutical Chemistry

AND one course selected from the list of electives on the following page.

Electives for Characterization of Inorganic and Organic Materials, Synthesis and Characterization of Inorganic Materials, and Synthesis and Characterization of Organic Materials

CHEM 509 Physical Methods of Characterization
CHEM 512 Spectroscopic Methods II
CHEM 535 Polymer Synthesis
CHEM 542 Polymer Characterization and Analysis
CHEM 543 Analytical Chemistry in Pharmaceutical Sciences

Radiological Physics

12 total credits selected from:

PHYS 561 Radiation Biophysics
PHYS 566 Environmental Health Physics
PHYS 571 Radiation Physics I
PHYS 572 Radiation Physics II
PHYS 573 Standards, Statutes and Regulations
PHYS 575 Case Studies in Health Physics
PHYS 576 Internal Dosimetry
PHYS 577 External Dosimetry
PHYS 578 Therapeutic Medical Physics I
PHYS 579 Therapeutic Medical Physics II
PHYS 770 Instrumentation for Radiation Health Physics

Course Descriptions

Numbers in parentheses represent class, lab and total credit hours, respectively.

Biology

BIOL 503
Virology
This course will cover topics related to animal viruses, including the cycle of major viral classes, viral pathogenesis, emergence, and control. Recent advances in these areas will be discussed in conjunction with readings from the original literature. Prerequisite: BIOL 445 or BIOL 544
(3-0-3)

BIOL 504
Biochemistry Lectures
Molecules of biological significance; reaction thermodynamics and kinetics; metabolism; cellular localization of biochemical function; proteins; nucleic acids; transcription; translation. Prerequisites: BIOL 115 and CHEM 237 or equivalent.
(4-0-4)

BIOL 511
Project Management: Business Principles
Introduction to concepts and techniques used to design and/or analyze a project to develop a set of tasks to accomplish the project, to coordinate and to monitor the work involved in the tasks, and to deliver a final product or service. Budgetary considerations will also be discussed.
(2-0-2)

BIOL 512
Advanced Biochemistry
This course provides a basic yet solid understanding of metabolism, enzyme mechanisms, and kinetics, as well as theoretical aspects of various laboratory techniques used in biochemistry. Prerequisite: permission of instructor.
(3-0-3)

BIOL 514
Toxicology
Initial lectures cover basic principles in chemical toxicity, such as dose response, indices of numerical toxicity, metabolism and factors influencing toxicity. Mechanisms of organic toxicity will be presented to include central nervous system, liver, kidney, respiratory system, reproductive system and the hematological system. Special topic lectures will emphasize the mechanism of toxicity for specific metals, pesticides, solvents and substances of abuse.
(3-0-3)

BIOL 515
Molecular Biology
A survey of topics including structure of nucleic acids, translation, transcription, replication, organization of DNA, RNA processing, genomics, and control of gene expression. Prerequisite: BIOL 401 or equivalent or instructor's consent.
(3-0-3)

BIOL 519
Biochemistry Laboratory
Introduction to modern biochemical techniques, including analytical methods for macromolecules, enzyme reactions, spectrophotometry, purifications, centrifugation, chromatography, electrophoresis, structure modeling. Prerequisite: Previous or concurrent enrollment in BIOL 401 or BIOL 504 or instructor's consent.
(0-9-3)

BIOL 520
Advanced Biochemistry Laboratory
A continuation of BIOL 519 in which students will undertake individual research projects. Prerequisite: BIOL 519 and instructor's consent.
(0-9-3)

BIOL 521
Advanced Micro Genetics Lab
Introduction to independent research in microbial physiology and genetics. Prerequisite: instructor's consent.
(0-9-3)

BIOL 522
Research Techniques in Biology
Experimental techniques in Biochemistry, Cell Biology, Biotechnology and Microbiology are offered as discreet modules. Students select appropriate modules to complement other laboratory courses. Thus, a student who has completed, for example, BIOL 519, (Biochemistry Laboratory) would select two modules chosen from Cell Biology, Biotechnology or Microbiology. A written report is required at the completion of each module.
(0-9-3)

BIOL 526
Developmental Biology
This course covers the cellular and molecular processes involved in generating an embryo, in creating various tissues and organs, and the effect of external stimuli on development. Topics include: genome structure, gene expression and regulation, cell cycle control, pattern formation, signal transduction, gametogenesis, organogenesis, and methods used in studying developmental biology. In addition to studies of model organisms, examples relevant to human diseases are covered.
(3-0-3)

BIOL 527
Immunology and Immunochemistry
Basic concepts of immunology and immunochemistry, both biological and molecular. Prerequisite: BIOL 401 or equivalent or instructor's consent.
(3-0-3)

BIOL 533
Laboratory in Cell and Molecular Biology
This course covers a number of essential techniques in cell and molecular biology with emphases on both the methodologies and the experimental details. Laboratory procedures include basic cell culture skills and relevant laboratory equipment usage. Experimental procedures include polymerase chain reaction and human DNA polymorphism, Drosophila polytene chromosome cytology, plasmid DNA preparation, western blot, gene delivery, yeast two-hybrid screens, immunofluorescence, immunoprecipitation, cell cycle arrest and analysis, and cell differentiation. Prerequisite BIOL 445 or instructor's consent.
(0-9-3)

BIOL 539
Advanced Cell Biology Laboratory
Introduction to independent research in cell and molecular biology. Prerequisite: BIOL 533 and instructor's consent.
(0-9-3)

BIOL 542
Advanced Microbiology
This course surveys a variety of topics regarding the biology of microbes. These include cell structure, metabolism, physiology, strategies for obtainng energy and how this relates to microbial ecology, genetics, and comparative genomics.
(3-0-3)

BIOL 544
Molecular Biology of Cells
This is a graduate level cell biology course. The course contains two parts: initial lectures cover cellular structure and function emphasizing the molecular components, organelles, and regulation of cellular process; the second part covers special topics emphasizing experimental approaches and molecular mechanisms of cellular regulation. Prerequisites: BIOL 115 and BIOL 214 or equivalent.
(3-0-3)

BIOL 545
Advanced Cell Biology Lectures
This course is a continuation of Biol 544 and focuses on recent advances in the area of cell biology. The course covers, in depth, eukaryotic cellular processes, structure-function relationships, and cellular signaling networks in response to physiological and pathological stimuli. The course will also cover frontier topics in the area of cell biology. Emphasis will be on experimental approaches. Prerequisites: BIOL 445/544 and BIOL 446/533, or instructor's consent.
(3-0-3)

BIOL 550
Bioinformatics and Biotechnology
This course will present an historical introduction to bioinformatics as a driving force for biotechnological advances. Topics covered will include: collecting and storing sequences in the lab; alignment of pairs of sequences; multiple sequence alignment; phylogenetic prediction; database searching for similar sequences; gene prediction; protein classification and structure prediction; and genome analysis.
(3-0-3)

BIOL 555
Macromolecular Structure Determination
Macromolecular crystallographic methods, including crystallization, data processing, phasing, and structure refinement; multi-dimensional NMR techniques; spectroscopic techniques; structural comparisons and characterizations; fiber diffraction and solution scattering. Prerequisite: instructor's consent.
(3-0-3)

BIOL 562
Current Topics in Functional Genomics
This course is designed to give students a foundation in advanced theoretical and applied methods in modern molecular research. It will emphasize both established and novel approaches to solving problems of functional and comparative genomics, and systems biology. It will also focus on applications of advanced molecular techniques in areas of significant economic and biomedical importance. Prerequisite: BIOL 515 or instructor's consent.
(3-0-3)

BIOL 572
Literature in Biochemistry
A topic from the current literature in biochemistry is selected by students for preparation of a paper. Prerequisite: instructor's consent.
(3-0-3)

BIOL 574
Literature in Biotechnology
A topic from the current literature in biotechnology is selected by students for preparation of a paper. Prerequisite: instructor's consent.
(3-0-3)

BIOL 576
Literature in Cell and Molecular Biology
A topic from the current literature in cell and molecular biology is selected by students for preparation of a paper. Prerequisite: instructor's consent.
(3-0-3)

BIOL 578
Literature in Microbiology
A topic from the current literature in microbiology is selected by students for preparation of a paper. Prerequisite: instructor's consent.
(3-0-3)

BIOL 580
Laboratory Rotation in Molecular Biochemistry and Biophysics
Short, individual research projects under the supervision of departmental faculty. Students will rotate through 2-3 different faculty laboratories in one semester. This helps ensure a good match between supervisor, project and student as well as provide a broader technical base to the student than provided in a single laboratory. This course may be taken twice. Prerequisite: instructor's consent.
(0-9-3)

BIOL 584
Graduate Seminar in Biology
To foster scientific communication skills, students are required to present seminars based on the scientific literature.
(1-0-1)

BIOL 591
M.S. Thesis Research
(Credit: Variable)

BIOL 595
Biology Colloquium
Lectures by invited scientists in areas of biology generally not covered in the department.
(1-0-1)

BIOL 597
Special Problems
(Credit: Variable)

BIOL 691
Ph.D. Thesis Research
(Credit: Variable)

Undergraduate Courses available to Graduate Students

BIOL 401
Introductory Biochemistry

BIOL 402
Metabolic Biochemistry

BIOL 410
Medical Microbiology

BIOL 414
Genetics for Engineering Students

BIOL 426
Concepts of Cancer Biology

BIOL 430
Animal Physiology

BIOL 445
Cell Biology

PHYS 410
Molecular Biophysics

Chemistry

CHEM 500
Advanced Analytical Chemistry
An overview of analytical chemistry with discussions of complex ionic equilibria, electroanalytical techniques including potentiometric, voltametric, coulometric and conductometric methods, ion chromatography, capillary electrophoresis and sensor technology.
(3-0-3)

CHEM 505
Spectroscopic Methods I
Theories of spectroscopic transitions and their applications in structural elucidations and quantitative analysis. Topics include ultraviolet/visible, infrared, Raman and nuclear magnetic resonance spectroscopy and mass spectrometry.
(3-0-3)

CHEM 506
Sampling and Sample Preparation
Techniques and devices for sampling in diverse media will be treated, followed by a discussion of sample treatment prior to analysis including isolation, concentration and fractionation of analytes and classes of analytes.
(3-0-3)

CHEM 508
Analytical Methods Development
A seminar course presenting analytical methods in complex matrices with emphasis on methods development and validation.
(2-0-2)

CHEM 509
Physical Methods of Characterization
A survey of physical methods of characterization including x-ray diffraction and fluorescence surface techniques, including SEM, TEM, AES and ESCA, thermal methods and synchrotron radiation methods.
(3-0-3)

CHEM 511
Project Management
Introduction to concepts and techniques used to design and/or analyze a project to develop a set of tasks to accomplish the project, to coordinate and to monitor the work involved in the tasks, and to deliver a final product or service. Budgetary considerations will also be discussed.
(2-0-2)

CHEM 512
Spectroscopic Methods II
A continuation of the study of optical methods covering atomic absorption spectroscopy, atomic and flame emission spectroscopy, chemiluminescence, fluorescence, phosphorescence, light scattering and refractometry.
(2-0-2)

CHEM 513
Statistics for Analytical Chemists
A survey providing sufficient statistical background for scientists. The topics covered include probability, statistics, sampling estimation, regression analysis, experimental design, data analysis and signal enhancement.
(3-0-3)

CHEM 515
Gas Chromatography - Theory and Practice
This course will cover theory and concepts of gas chromatographic analysis and its practical application in solving analytical problems. Topics include basic theory of chromatographic separation, separation dynamics, instrumentation, column selection, quantitative techniques, and practical applications.
(3-0-3)

CHEM 516
Liquid ChromatographyTheory and Practice
This course will cover the operating principles and applications of the state of the art LC/HPLC instrumentation and analysis. Topics include basic theory of liquid chromatography, instrumentation, optimization of LC separation, quantitative techniques, and the diverse range of analytical applications amenable to LC analysis. Prerequisite: CHEM 515.
(3-0-3)

CHEM 520
Advanced Inorganic Chemistry
Selective treatment of the chemistries of main group and transition elements with emphasis on coordination complexes, organometallic compounds and inorganic cages and clusters. Discussions of molecular symmetry, stereochemistry, bonding, electronic spectra, magnetic properties, reactions, kinetics and reaction mechanisms are included.
(3-0-3)

CHEM 521
Structural Inorganic and Materials Chemistry
This course covers structure and bonding and structure-property relationships in inorganic molecules and solids. Descriptions of crystal structures, spectroscopic and x-ray diffraction techniques for structure determination and properties of solids are included.
(3-0-3)

CHEM 522
Efficient Synthesis and Catalytic Chemistry
Environmentally benign chemical pathways. High-yield and zero-waste chemical processes. Sustainability, representative industrial chemical processes, catalytic chemistry .
(3-0-3)

CHEM 524
Synthesis and Intellectual Property Management
This course focuses on the management of intellectual property. Professionals will lead discussions on the control and dissemination of materials concerning intellectual property. This will be combined with technical presentations by students in the classroom. Topics of discussion will include invention disclosures, intellectual property rights, proprietary materials, justification for patents, types of patents, terms of a patent, patents procedure, licensing procedure and security considerations. Access to patented materials and disclosure of materials under patent process will be covered.
(2-0-2)

CHEM 530
Organic Reaction Mechanisms
A study of important mechanism classes and their relationship to the major reactions of organic chemistry. Emphasis will be placed on the study of reaction intermediates and on the methods used to characterize reaction pathways. Topics will include chemical bonding, aromaticity, stereochemistry, substitution, elimination, carbanion chemistry, free radical reactions, photochemistry and concerted reactions. Prerequisite: CHEM 455 or equivalent is recommended.
(3-0-3)

CHEM 531
Tactics in Organic Synthesis
A study of modern synthetic strategies used in the preparation of complex organic molecules. Synthetic planning using the disconnection approach and the selection of reagents to solve regiochemical and stereochemical problems will be the underlying themes. Synthetic strategies to be discussed include tandem reactions, template and chelation effects, biomimetic tactics and the use of chiral terpenes, carbohydrates and amino acids in enantioselective syntheses. Target molecules will include natural products, pharmaceuticals and smart organic materials. Prerequisite: CHEM 530.
(3-0-3)

CHEM 535
Polymer Synthesis
In-depth study of polymer synthesis, kinetics of polymerization, solution and thermal properties, processing and characterization techniques and rheological behavior. Selected topics include high-performance polymers, conducting polymers, electrooptical polymers, water-soluble polymers, biopolymers, medicinal polymers, photosensitive polymers and liquid crystalline polymers. Prerequisite: CHEM 470 or instructor's consent.
(3-0-3)

CHEM 537
Polymer Chemistry Laboratory
This course will include the synthesis of a variety of polymers and their characterization using instrumental methods. Emphasis will be placed on factors that control polymer formation, methods for obtaining molecular weights and distributions of polymers, as well as thermal and mechanical characteristics of polymers. Prerequisite: CHEM 470 or instructor's consent.
(1-6-3)

CHEM 538
Physical Biochemistry
The principles and techniques of physical chemistry applied to proteins, nucleic acids, polysaccharides and lipids. Prerequisites: CHEM 239, CHEM 344 (or equivalent).
(3-0-3)

CHEM 539
Introduction to Pharmaceutical Chemistry
Fundamental concepts will be discussed, including modern principles of drug design; drug absorption, distribution and metabolism; theories of drug-receptor interactions; approaches to structure-activity relationships; chemical, physicochemical and structural considerations. The various classes of therapeutic agents will be surveyed with emphasis on possible modes of action. Methods of synthesis will be considered. Prerequisites: CHEM 239.
(3-0-3)

CHEM 542
Polymer Characterization and Analysis
Overview of various characterization and analysis techniques in polymer science and technology, such as thermal analysis, mechanical property measurements, chromatographic separations, techniques for the determination of molecular weights and chemical analysis of polymer additives in polymer research, product development, quality control and degradation studies. A general discussion on industrial problem solving using multiple characterization techniques.
(3-0-3)

CHEM 543
Analytical Chemistry in Pharmaceutical Laboratories
This course is designed to compliment the current curriculum of the professional master degree in analytical chemistry. It is a review of the requirements a student may face as a professional chemist in a regulated industry. The course focus is on the requirements and common topics facing today's pharmaceutical industry. While individual agencies have specific regulations, the fundamental ideas of these regulations are largely consistent across the board. For example, an analytical chemist versed in Good Laboratory Practices (GLP) under FDA can quickly pick up the GLP's required by EPA.
(2-0-2)

CHEM 544
Colloids and Colloid Analysis
This course will begin a general overview of colloid science. This part of the course will introduce various types of colloids, touch on factors and conditions leading to their stability or instability, consider their evolution and will include a very limited discussion of the conditions under which they can form. The second part of the course will consist of a series of discussions of specific analytical techniques used to characterize colloidal systems, with particular emphasis on the physical characterization of the dispersed phase.
(2-0-2)

CHEM 550
Quantum Chemistry
Postulatory basis of quantum mechanics. Applications to molecules and band theory, and to interpretation of bond formation via spectroscopy. Range of models from 1-D rectangular well to complex molecules. Approximation methods such as Moller-Plesset Perturbation Theory, and Density Functional Theory, and their application to estimation ofphysical properties of complex molecules including transition states in reaction mechanisms and simulation. Prerequisites: Chem 344 or consent of instructor.
(3-0-3)

CHEM 552
Chemical Kinetics
Types of reactions, reaction order, activation energy, transition states, isotope effects and the mechanism of reactions. Determination of the rates of free radical reactions. Primary processes in thermal, photochemical and other radiation-induced reactions. Prerequisites: CHEM 550, CHEM 553 (or equivalent).
(3-0-3)

CHEM 553
Introduction to Chemical Thermodynamics
Fundamental laws of thermodynamics; application to simple chemical systems. Prerequisite: CHEM 344 or equivalent.
(3-0-3)

CHEM 560
Advanced Chemistry Projects
Advanced chemistry projects to be carried out under the direction of a faculty member. These projects may involve computational, theoretical, experimental work or a combination of these. Projects based on experimental work may be carried out in the research lab of the instructor. Topics of the advanced projects will be selected by the faculty member offering the course and will not necessarily be related to the dissertation topic of the student.
(0-12-4)

CHEM 584
Graduate Seminar in Chemistry
To foster scientific communications skills, students are required to present seminars based on the scientific literature. Required of all first-year M.S. and Ph.D. students.
(1-0-1)

CHEM 585
Chemistry Colloquium
Lectures by invited scientists in areas of chemistry generally not covered in the department. Must be taken two times by M.S. students and four times by Ph.D. students.
(1-0-1)

CHEM 591
Thesis Research
(Credit: Variable)

CHEM 594
Special Problems
Designed for non-thesis M.S. only.
(Credit Variable)

CHEM 597
Reading and Special Problems
Independent study to meet the special needs of graduate students in department-approved graduate degree programs. Requires the written consent of the instructor. May be taken more than once. Receives a letter grade.
(Credit Variable)

CHEM 610, 611
Special Topics in Analytical Chemistry
Topics of current interest in analytical chemistry including advanced electrochemistry, surface spectroscopy of electrode surfaces, separations, laboratory automation and new spectroscopic techniques.
(2-0-2;2-0-2)

CHEM 620, 621
Special Topics in Inorganic Chemistry
Topics of current interest in inorganic chemistry, including organometallic chemistry, homogeneous catalysis, inorganic reaction mechanisms, inorganic stereochemistry, materials chemistry, x-ray crystallography, synthetic and physical methods in inorganic and materials chemistry and chemical applications of group theory.
(2-0-2;2-0-2)

CHEM 630, 631
Special Topics in Organic Chemistry
Topics of current interest in organic chemistry including photochemistry, fluorine chemistry, heterocyclic chemistry, pharmaceutical chemistry and electrooptical organic chemistry. Prerequisite: CHEM 455 or instructor's consent.
(2-0-2;2-0-2)

CHEM 635
Heterocyclic Chemistry
Of the vast array of structures which organic compounds adopt, many contain ring systems as a component. When the ring is made up of carbon and at least one other element, the compound is classified as a heterocycle. The aims of this course are to identify the effects that the presence of such ring systems have on the chemistry of a molecule; to show how the rings can be made, and to describe some of the uses of the compounds in organic synthesis, in medicine and in other contexts. The chemistry of aromatic five-, six- and seven-membered ring compounds with one or more nitrogen, oxygen and/or sulfur atoms will be emphasized. Prerequisite: CHEM 531.
(3-0-3)

CHEM 650, 651
Special Topics in Physical Chemistry
Topics of current interest in physical chemistry, including atmospheric chemistry, ion molecule reactions, laser chemistry, theories of gas phase reactions, scattering theory, interaction of radiation with matter, and time-dependent relaxation methods.
(2-0-2;2-0-2)

CHEM 684
Graduate Seminars in Chemistry
To foster scientific communications skills, students are required to present seminars based on the scientific literature. Required of all Ph.D. students who have passed the written qualifying examination.
(1-0-1)

CHEM 685
Chemistry Colloquium
Lectures by invited scientists in areas of chemistry generally not covered in the department. For full-time graduate students who have completed the CHEM 585 requirement.
(1-0-1)

CHEM 691
Ph.D. Thesis Research
(Credit Variable)

Undergraduate Chemistry Courses Available to Graduate Students

CHEM 415
Inorganic Chemistry

CHEM 416
Advanced Chemistry Laboratory

CHEM 45
Physical Chemistry III

CHEM 451
Modern Techniques in Chemical Literature

CHEM 454
Computer Applications in Chemistry

CHEM 455
Advanced Organic Chemistry

CHEM 470
Introduction to Polymer Chemistry

Physics

PHYS 501, 502
Methods of Theoretical Physics I, II
Linear vector spaces. Functions of a complex variable. Fourier series and integrals. Differential and integral equations. Special functions. Green's functions. Group theory. Prerequisite: MATH 252.
(3-0-3;3-0-3)

PHYS 505
Electromagnetic Theory
Maxwell's equations. Electromagnetic waves and radiation. Prerequisites: PHYS 414, MATH 252.
(3-0-3)

PHYS 507
Electrodynamics
Covariant formulation of Maxwell's equations. Variational principles of classical field theory. Theory of radiation reactions. Topics in contemporary electrodynamics. Prerequisite: PHYS 505.
(3-0-3)

PHYS 508
Analytical Dynamics
Newton's laws. Lagrange's equations. Central forces. Invariance properties and conservation laws. Collections of particles. Rigid body motions. Small vibrations. Hamilton's equations. Canonical transformations. Hamilton-Jacobi theory. Approximation methods. Special theory of relativity. Classical theory of fields. Prerequisites: PHYS 309, MATH 252. Recommended corequisite: PHYS 501.
(3-0-3)

PHYS 509, 510
Quantum Theory I, II
Postulates and theory of measurement in quantum mechanics. Momentum eigenstates, wave packets and passage to the classical limit. Angular momentum eigenstates. Stationary states of a particle in central field. Approximation methods. Identical particles, introduction to second quantization. Transition probabilities. S matrix formalism, approximation methods for decay and scattering problems. The Lorentz group and relativistic wave equations. Dirac particle in a central field. Prerequisites: PHYS 406, PHYS 501, PHYS 508 or instructor's consent.
(3-0-3;3-0-3)

PHYS 511, 512
Advanced Quantum Mechanics I, II
Applications and extensions of basic principles introduced in PHYS 509 and PHYS 510. Typical subject areas include atomic and molecular structure, group-theoretical analysis of spectra, many-body problems, including second quantization, density matrix. Hartree-Fock method. BCS theory. Introduction to quantum fields. Feynman diagrams. Green's functions, quantum electrodynamics. Prerequisites: PHYS 509, PHYS 510.
(3-0-3)

PHYS 515
Statistical Mechanics
Kinetic theory and Boltzmann's H-theorem. Quantum statistics. Fermi-Dirac and Bose-Einstein systems. Density matrix. Fluctuations. Behavior of complex and chaotic systems. Prerequisites: PHYS 304, PHYS 406 and PHYS 508, or instructor's consent.
(3-0-3)

PHYS 521
Quantum Electronics
The Schrodinger equation. Matrix formulation. Quantization of lattice vibrations and electromagnetic fields. Optical beams and resonators. The interaction of radiation and atomic systems. Lasers. Optical waveguides and devices. Frequency conversion. Quantum noise. Same as ECE 521. Prerequisite: ECE 307 or instructor's consent.
(3-0-3)

PHYS 533
Group Theory in Physics
Development of the theory of finite groups and group representations and application to diverse subjects in physics. Point groups. Introduction to SU(2) and the rotation group. Spinors and tensors. Prerequisite: MATH 252.
(3-0-3)

PHYS 537, 538
Solid State Physics I, II
Crystal structure and crystal binding. Lattice vibrations and phonons. Free electron model of metals and semiconductors. Energy band theory. Transport phenomena. Magnetic, optical properties of solids. Superconductivity. Prerequisites: PHYS 406, MATH 252.
(3-0-3;3-0-3)

PHYS 545, 546
Particle Physics I, II
Principal theories of elementary particles and their interactions, including important features of experimental data. Mesons, baryons and leptons. Particle classification schemes. Brief introduction to quantum field theory and Feynman diagrams. Strong, electromagnetic and weak interactions. Scattering matrix. Phenomenological descriptions of high-energy scattering and particle production. Speculations on quarks, magnetic monopoles and other exotic particles. Prerequisite: PHYS 510 or instructor's consent.
(3-0-3)

PHYS 553
Quantum Field Theory
Relativistic wave equations. Semiclassical and quantum theories of radiation. Photoelectric effect. Pair production. Bremsstrahlung. Compton scattering. Second quantization of the electron field. Renormalization. Lamb shift. Vacuum polarization. Exact methods for external field problems. Prerequisite: PHYS 505.
(3-0-3)

PHYS 561
Radiation Biophysics
Energy loss by ionizing radiation. Target theory. Direct and indirect action. Radiation effects in iomolecules. Radiation inactivation of enzymes, nucleic acids and viruses. Biological effects of ultraviolet radiation. Photosensitization. Radiation protection and sensitization. Radiation effects in vivo, radiation therapy, phototherapy. Prerequisite: PHYS 410 or instructor's consent.
(3-0-3)

PHYS 570
Introduction to Synchotron Radiation
Production and characterization of synchrotron radiation, dynamical and kinematical diffraction, absorption and scattering processes, x-ray optics for synchrotron radiation, and x-ray detectors. Overview of experimental techniques, including XAFS, XPS, SAXS, WAXS, diffraction, inelastic x-ray scattering, fluorescence spectroscopy, microprobe, tomography and optical spectroscopy.
(3-0-3)

PHYS 571
Health Physics I
Fundamentals of health physics will be presented, with an emphasis on problem-solving and computer modeling. Topics covered begin with the physics of radiation production: review of atomic and nuclear structure and quantum mechanics; nuclear structure and radioactivity; production of x-rays. The second part of the course focuses on the interaction of radiation with matter, including energy-loss mechanisms, secondary processes, stopping power and range. Required prerequisites: MATH 252, PHYS 203. Suggested prerequisite: PHYS 348.
(3-0-3)

PHYS 572
Health Physics II
Continuation of the basic health physics sequence, including neutron production and interaction with matter; methods of radiation detection; radiation dosimetry; chemical and biological effects of radiation; radiation protection standards; shielding; dosimetric models; accelerator, reactor and medical health physics. Prerequisite: PHYS 571.
(3-0-3)

PHYS 573
Standards, Statutes, and Regulations
This course studies the requirements of agencies that regulate radiation hazards, their basis in law and the underlying U.S. and international standards. An array of overlapping requirements will be examined. The effect regulatory agencies have upon the future of organizations and the consequences of noncompliance are explored.
(3-0-3)

PHYS 575
Case Studies in Health Physics
Issues in operational health physics and regulatory affairs. Students will present problems and solutions drawn from their experience and the literature. Operational problems may include organizational issues, computer applications, measurements and dosimetry. Methods for compliance with EPA, NRC and OSHA and enforcement actions will emphasize technical and management techniques.
(3-0-3)

PHYS 576
Internal Dosimetry
Calculation of internal dose from radiation sources. Internal dose is a function of the form of radiocative material, route of intake, biochemistry, metabolic activity, and gross and cellular physiology.
(2-0-2)

PHYS 577
External Dosimetry
Calculation of external dose from radiation sources. External dose is determined for uniform fields, nonuniform fields, and local deposition. External sources include immersion in a cloud of radioactive gas and skin contamination.
(2-0-2)

PHYS 578
Therapeutic Medical Physics I
Fundamentals of therapeutic medical physics are presented with emphasis on clinical applications, problem solving and computer modeling. Topics covered begin with description of treatment machines for external beam radiotherapy, including clinical accelerators for x-ray, electron and proton radiotherapy; AAPM TG-21 and TG-51 protocols; Classical radiation therapy. Prerequisite: PHYS 572 or consent of instructor.
(2-0-2)

PHYS 579
Therapeutic Medical Physics II
Advanced topics in radiation therapy physics will be covered. Topics covered begin with three dimensional conformal radiation therapy followed by clinical dose computation algorithms: Convolution-Superposition Methods and direct Monte Carlo methods. Following topic is Intensity Modulated Radiation Therapy (IMR T), which will cover in details mathematical, physical and biological optimizations of beam intensity, IMRT dose delivery methods, and quality assurance aspects. Last topics to be covered are High Dose Rate (HDR) Brachytherapy and Stereotactic Radiosurgery. Required prerequisite: PHYS 578.
(2-0-2)

PHYS 585
Physics Colloquium
Lectures by invited scientists in areas of physics generally not covered in the department. Must be taken twice by M.S. students and four times by Ph.D. students.
(1-0-1)

PHYS 591
Thesis Research
(Credit Variable)

PHYS 597
Reading and Special Problems
ndependent study to meet the special needs of graduate students in department-approved graduate degree programs. Requires the written consent of the instructor. May be taken more than once. Receives a letter grade.
(Credit Variable)

PHYS 685
Physics Colloquium
Lectures by invited scientists in areas of physics generally not covered in the department. For full-time graduate students who have completed the PHYS 585 requirement.
(1-0-1)

PHYS 691
Thesis Research
(Credit Variable)

PHYS 770
Instrumentation for Radiation Health Physics
Detecting and measuring radioactive material and radiation levels depends upon many types of detectors and instrumentation. Theory of detectors ranging from chambers operating in pulse and current producing modes to solid-state detectors is applied to measuring and monitoring systems. Electronics ranging from simple-rate meters and scalers to high-speed multichannel analyzers is used. Computer linked instrumentation and computer-based applications are applied to practical problems.
(0-6-2)