DIVISION I

This division includes the Departments of Biology, Chemistry, Mathematics and Computer Science, and Physics.

Faculty 2005-2006
Polley, L.D. (chair)
Axtell, M.
Brown, J.
Dallinger, R.
Feller, S.
Foote, R.
Hansen, R.
Ingram, A.
Krause, D.
Krohne, D.
Le Plae, P.
Maharry, D.
Munford, J.
Nelson, R.
Olsen, R.
Phillips, J.D.
Poffald, E.
Porter, L.
Selvaratnam, S.
Taylor, A.*
Thompson, P.
Turner, W.
Westphal, C.
Wetzel, E.
Wyman, A.

**Sabbatical leave, full year*

Concentration in Division I: For requirements for the major or minor in the departments of Division I, see departmental listings.

Unless otherwise indicated, all courses in Division I are without prerequisite.

Department of Biology

Faculty: D. Krohne (chair), A. Ingram, J. Munford, R. Nelson, L.D. Polley, S. Selvaratnam, E. Wetzel

The curriculum of the Biology Department is designed to introduce the student to the breadth of the discipline of biology and to provide the foundation for further study in biology. A core sequence of courses introduces the student to genetics, cell biology, organismal, biology, and ecology. The student may then choose elective courses in areas relevant to his career interests. The biology major is designed to prepare the student for graduate or professional work in biology as well as other careers such as law or business.

We emphasize the process of biological science through course content, laboratory and field work, independent study, and summer research with faculty. The capstone course, Biology 401, introduces the student to the primary literature in biology and the skills needed to analyze critically new information in biology.

For the non-major we offer a number of opportunities to study biology. For the student looking for a laboratory course for distribution, Biology 101 introduces the basic concepts of biology by examining the biology of humans. This course can also be used as an entry point for additional work in biology since it is a prerequisite for several of courses in the department.

Requirements for the Major: Students majoring in biology must complete: (1) a core of 7 course credits; (2) 2 additional course credits in biology; (3) Physics 111; (4) Chemistry 111 and 221; (5) Comprehensive exam in biology.

The Biology Core Curriculum: Biology 111, 112, 211, 213, 212, 401, and one of the following: 221, 222, 224, 225, 226.

Introductory Courses (two course credits): Students will begin their major in biology by taking Biology 111 and 112. These courses will be completed during the freshman year.
Genetics and Cell Biology (one course credit each): Biology 211 and 212 must be completed during the sophomore year.

Organismal Biology (one course credit): one of these courses:

Biology 221 (Comparative Anatomy and Embryology of the Vertebrates)

Biology 222 (Biology of the Invertebrates)

Biology 224 (Biology of the Vascular Plants)

Biology 225 (Microbiology)

Biology 226 (Parasitology)

This requirement must be completed after the Introductory Courses and before the beginning of the second semester of the senior year.

Ecology (one course credit): Biology 213 must be completed during the first semester of either the junior or senior year. Students taking Biology 213 in their senior year must have completed the Organismal Biology requirement in a previous semester.

Senior Seminar (one course credit): Usually Biology 401 is taken during the first semester of the senior year. Students who will be off-campus during the first semester of their senior year should take Biology 401 during the first semester of their junior year.

Supporting Biology Curriculum: Biology majors must complete 2 additional course credits for a total of nine course credits in biology. These credits may be compiled from the following: Biology 151, 221, 222, 224, 225, 226, 311, 313, 225, 315, 314, 202, 387, 388. Because some of these courses (Biology 224, 226, 311, 313, 315 and 314) are offered in alternate years, students must carefully plan their curriculum, (in consultation with a Biology Department faculty member). In some years, one or more special topics courses (Biology 371) may be offered and may be used to complete the major. Descriptions of these courses will be provided to students and advisors before advance registration.

Students interested in biological research are encouraged to undertake Independent Study (Biology 387, 388) during their junior or senior year. Well-prepared students may begin Biology Independent Study before their junior year.

Beyond the nine course credits required for the biology major, students may include two additional biology course credits to satisfy graduation requirements. Students interested in graduate school in biology are encouraged to consider this option.

Supporting Physics, Chemistry and Mathematics/Computer Science Curriculum: Physics 111 and Chemistry 111 and 221 are required. Students intending to proceed either to a professional or a graduate school should plan to include Mathematics 111, Physics 112 or 113, and Chemistry 222, 231, and 241 in their curriculum. Usually Chemistry 111 and 221 are taken during the sophomore year; Physics 111 and 112 or 113 and Chemistry 222, 231, and 241 are taken during the junior year. Mathematics 112, Computer Science 111, and a statistics course (Mathematics 217 or Division III 252) may be important support courses for some biology majors.

Comprehensive Exam in Biology: Students must pass a two-day written comprehensive exam in biology. On the first day, students write on a series of recent papers from the primary literature drawing upon the breadth and depth of their knowledge of biology. On the second day they answer a series of questions on specific courses.

Off-campus study: Students who wish to take biology courses at other institutions to be credited towards graduation should first discuss their options with their advisor and then obtain permission from the Biology department chair.

Summer Field Study: Scholarship funds are available through the Lucy B. Graves Fund as scholarships for students to study at marine biological laboratories. The Robert O. Petty Fund and the E.W. Olive Fund support interns in field biology. Interested students should talk with the department chair.

Requirements for the Minor: Biology 111, 112, and three other course credits in the department. At least one of the courses beyond Biology 111, 112 must be a laboratory course. Students who wish to initiate a biology minor via the Biology 101 course will complete four additional courses.

Course Descriptions

101. Human Biology
A one-semester course offered primarily for majors in the social sciences and the humanities. This course will emphasize reproduction and development, structure/function, genetics, and evolution. The ethical implications of biological knowledge also will be considered. In the laboratory, students will investigate biological problems related to humans. Three lecture/discussions and one laboratory period weekly. A student who decides, on the basis of his experience in Biology 101 to major in biology can enroll in the appropriate semester of Biology 111, 112.

One course credit each semester.

102. Plants and Human Affairs
This non-majors course will explore the interface between humankind and the plant world. Through lectures/discussion, ancillary readings and www.exercises and demonstrations, students will study the impact that plants have had on the development of human culture. Some topics to be covered include the plant body, photosynthesis, economically important plants, plant genetics and biotechnology, flowers and plants in the environment. Attention will be given to modes of inquiry in the plant sciences. Several field trips are planned. *Prerequisite: Biology 101.* Does not count toward the laboratory science distribution requirement.

One course credit, spring semester.

111, 112. General Biology
A year course in the concepts of biology for biology majors. This course is a prerequisite for all advanced courses in biology. Biology 111 covers biomolecules, cell biology, genetics, and evolution. Biology 112 covers animal and plant structure/functions, evolution and ecology. Three lectures and one laboratory period weekly. *Biology 111 is a prerequisite for Biology 112.*
One course credit each semester.

151. Evolution
A general study of evolution. Lecture/discussion focuses on the processes of evolutionary change and the origin of life. Current controversies and human evolution are considered. *Prerequisite: Biology 111 or 101.*

One course credit, spring semester.

202. Electron Microscopy
A laboratory course covering specimen preparation, microtomy, staining, operation of the transmission and scanning electron microscope, and darkroom methods. *Prerequisite: Biology 101 or 112 and consent of the instructor.*

One-half course credit, spring semester.

211. Genetics
A course designed to introduce the modern concepts of the gene. The lectures stress the theory and experimental evidence relating to transmission, molecular, and developmental genetics. The laboratory is investigative in nature. *Prerequisite: Biology 112 or permission of the instructor.* (This course should be taken during the sophomore year.)

One course credit, fall semester.

212. Cell Biology
The primary emphasis of this course is the structure and function of the eukaryotic cell. Lectures, readings, and discussions will cover cellular organelles, types, metabolism, interactions, and regulation of activities. The laboratory focuses on cellular structure and function through the techniques of modern cell biology. *Prerequisite: Biology 112 or permission of the instructor.* (This course should be taken during the sophomore year.)

One course credit, spring semester.

213. Ecology
An introduction to the interrelations of plants and animals with their environment. Terrestrial and aquatic ecosystems are considered. Some weekend field trips are included. *Prerequisite: Biology 112 or 101 with permission of the instructor.*

One course credit, fall semester.

221. Comparative Anatomy and Embryology of the Vertebrates
A course presenting a broad evolutionary theme of the vertebrates using the facts of comparative anatomy, embryology, and paleobiology. *Prerequisite: Biology 101 or 112.*

One course credit, fall semester.

222. Biology of the Invertebrates
A course designed to provide students with an introduction to the diversity of invertebrate organisms through lectures, reading and discussion of primary literature, student presentations, and laboratory work. Emphasis is placed on structure, functional morphology, physiology, ecology, and evolution. A field trip to a marine field station has been included in the past few years. *Prerequisite: Biology 101 or 112.*

One course credit, spring semester, 2006-2007 and alternate years.

224. Biology of the Vascular Plants
An introduction to the science of botany. A strong emphasis will be placed on the evolutionary trends in the vascular plants, with additional coverage of plant biotechnology, developmental biology, and some of the physiological adaptations plants have evolved in the transition to life in terrestrial environments. The laboratories will be primarily observational, with a broad exposure to plant diversity and taxonomy; substantial field work is planned. *Prerequisite: Biology 101 or 112.*

One course credit, spring semester, 2005-2006 and alternate years.

225. Microbiology
This course is designed to introduce the student to the lifestyles and impact of the smallest organisms known. Lecture/discussion will examine topics such as microbial cell structure and function, growth and nutrition, genetics, antibiotics and pathogenesis, and microbial diversity. The laboratory is organized around an investigative, discovery driven project. *Prerequisite: Biology 111 and 112 or permission of instructor.*

One course credit, fall semester; not offered 2005-2006.

226. Parasitology
A course designed to introduce students to the major groups of animal parasites. Emphasis in lectures and discussion of primary literature is placed on general principles, including diversity, morphology, transmission biology, and the ecology and evolution of the different parasite taxa. The laboratory work includes the detailed consideration of particular parasite species as representatives of larger groups, as well as an independent research project on the parasites of a selected host species. *Prerequisite: Biology 101 or Biology 112 or permission of instructor.*

One course credit, fall semester, 2005-2006 and alternate years.

311. Molecular Genetics
A course designed to explore in detail the molecular biology of the gene. Lecture/discussion will focus on areas of current interest and will include analysis of experimental evidence which underpins our understanding of gene structure and function. The laboratory is investigative in nature and provides primary experience with recombinant DNA technology genomics and bioinformatics. *Prerequisite: Biology 211.*

One course credit, spring semester, 2006-2007 and alternate years.

313. Advanced Ecology
This course emphasizes the investigative approach to ecology including experimental design and data analysis. Lectures/discussions focus on areas of current interest in ecosystem, community, and population ecology. Several field trips and an independent investigation are required. *Prerequisite: Biology 213.*

One course credit, spring semester, 2005-2006 and alternate years.

314. Developmental Biology
Through lectures, current readings and discussions, this course considers the principles of development with emphasis on experimental evidence for underlying mechanisms. The laboratory work includes molecular, cellular and supracellular approaches to the investigation of developmental questions in animals and plants. *Prerequisite: Biology 211.*

One course credit, spring semester, 2005-2006 and alternate years.

315. Organismal Physiology
The major physiological systems (nutrition, transport, gas exchange, elimination of wastes, coordination, and defense) are considered from the adaptational perspective. The emphasis is on the physiological system as it is related to the survival of vertebrates in their natural environments. The laboratory focuses on physiological techniques and methods of analysis. *Prerequisite: Biology 212 or permission of the instructor.*

One course credit, fall semester, 2005-2006 and alternate years.

371. Special Topics
Innovative courses and special programs in library research. Descriptions of special topics courses will be posted at the time of advance registration. Students desiring a special library research project should make the appropriate arrangements with individual faculty members.

One-half course credit.

387, 388. Introduction to Research
Individual research on selected problems. Although only one-half course credit is to be counted toward the 9 credit major, these courses may be repeated and credit received for graduation. Students should make arrangements with individual faculty members during the semester preceding their enrollment in the course.

One-half course credit each semester.

401. Senior Seminar
A seminar course required of all majors. Critical reading of primary literature, oral expression and experimental design are emphasized. Students intending to be off-campus during the first semester of their senior year should take this course during their junior year.

One course credit, fall semester.

Department of Chemistry

Faculty: R. Olsen (chair), R. Dallinger, S. Feller, P. LePlae, L. Porter, A. Taylor*, A. Wyman

** Sabbatical leave, full year*

The Wabash College Chemistry Department believes in a challenging curriculum which thoroughly investigates all areas of modern chemistry and in a significant hands-on investigative laboratory experience in which students become progressively more independent as they proceed through the curriculum. We believe that such an education will prepare chemistry majors for a variety of career outcomes, including those in research, medicine, teaching, and industry. In recent years, three-fourths of our majors have gone directly to graduate school in chemistry/ biochemistry or to medical school immediately following graduation. Others have chosen to take jobs as chemists or to attend other professional schools (business, law, and physical therapy). We strive to provide chemistry minors and pre-medical students with the knowledge base they need to succeed in their chosen fields. We seek to involve all Wabash students in the study of chemistry through non-majors courses — Chemistry 101 and 102. We attempt to teach all chemistry students about the relationship between chemistry and the world around them.

Requirements for the Major: A chemistry major requires completion of the following core courses (eight credits): 111, 221, 222, 231(1/2 credit), 241 (1/2 credit), 331, 351, 361, and 441. Students may complete the nine-course requirement by selecting among the following electives: 421, 431, 451, 452, 461, 471, 487, 488. Chemistry 421, 452, 461 and 471 may be repeated when the topics change. No more than one-half course credit of independent study (Chemistry 487 or 488) may be used to construct the minimum nine-course major. Chemistry 101 and 102 do not count toward the major.

The following courses are also required for chemistry majors—Mathematics 111 and 112, Physics 111 and Physics 112 (Chemistry/Physics double majors and Physics minors will take Physics 111, 113 and 114). The mathematics courses are best taken in the freshman year, and the physics sequence should be taken in the sophomore year, because physical chemistry (taken by all junior chemistry majors) has a two-course physics prerequisite.

The **written comprehensive examination** for senior majors emphasizes both knowledge of basic chemical concepts and the ability to apply these concepts to new problems. One part of the exam involves reading and answering questions over several articles from the recent chemical literature; the second part of the exam involves answering questions from the core chemistry courses the student has taken.

Chemistry majors who wish to transfer chemistry credits from another institution as part of their major must have the prior approval of the Department Chair to do so.

Chemistry Major with Biochemistry Emphasis: Students with a special interest in Biochemistry may complete a Chemistry major with an emphasis on Biochemistry (the Biochemistry Track). Students pursuing the Biochemistry Track will take the eight-course core Chemistry curriculum described above, and will complete the minimum nine-course major by

taking two half-credit special topics courses which have a biochemistry emphasis. Research in biochemistry is also encouraged, although this will take the student beyond the nine course minimum Chemistry major. Additionally, the Biochemistry Track student will be required to take the following courses in the Biology Department—Bio 111 and Bio 112 (General Biology), Bio 211 (Genetics), Bio 212 (Cell Biology) and one approved Molecular Biology elective, such as Bio 311 (Molecular Genetics), Bio 314 (Developmental Biology), Bio 371 (Special Topics courses with suitable topics) or other approved courses. Students and their academic advisors should consult with the Chemistry Department Chair as they plan the course work for the Biochemistry Track Chemistry major.

Requirement for the Minor: The following courses are required for the chemistry minor-Chemistry 111, 221, and 231 (1/2 course credit). The student may select any other 2-course credits from the departmental offerings (except Chemistry 101 and 102) to complete the minor, provided the prerequisites for the courses are met. No more than one-half course credit of independent study (Chemistry 487, 488) may be used to construct the minimum five-course minor.

Chemistry minors who wish to transfer chemistry credits from another institution as part of their minor must have the prior approval of the Department Chair to do so.

Requirements for Premeds: Premedical students are required to take four courses in chemistry before the end of their junior year (when the MCAT examination is generally taken). Wabash pre-med students should take the following courses to meet the premed chemistry requirement—Chemistry 111, 221, 222, 231, (1/2 course credit) and 241 (1/2 course credit). Advanced Placement: Please refer to the College Advanced Placement guidelines under Credit by Examination. Potential chemistry majors and minors who wish to claim advanced placement credit should discuss placement options with the Department Chair. If the Chair and the student decide that it is in the student's best interest to take Chemistry 111, the advanced placement chemistry credit must be forfeited.

ACS Certified Degree: To meet the certification requirements formulated by the American Chemical Society Committee on Professional Training (CPT) as a chemist and for adequate preparation for graduate school, additional classroom and laboratory work beyond the minimum nine-course major is required. The student should consult with the Chair of the Chemistry Department concerning ways in which the remaining requirements may be fulfilled. The requirements formulated by the CPT include: (1) the equivalent of year-long courses in analytical, inorganic, organic and physical chemistry; three-fourths of a year of advanced work which is based upon a physical chemistry prerequisite; (2) a year of physics; (3) calculus through partial derivatives and simple differential equations; (4) 500 laboratory hours (which can include research). Advanced courses in physics and in differential equations are recommended. The satisfaction of the graduation requirements of the College will meet the CPT requirements in English and the Humanities.

Suggested order of courses for the chemistry major:

Freshman:

Chemistry 111, 221 (required for major)
Mathematics 111, 112 (prerequisite for Chemistry 231)

Sophomore:
Chemistry 222, 231, 241 (required for major)
Physics 111 and 112 (prerequisite for Chemistry 351)

Junior:
Chemistry 331, 351, 361 (required for major)
Chemistry 421*, 487*, 488* (electives)

Senior:
Chemistry 441 (required for major)
Chemistry 421*, 431*, 451*, 452*, 461*, 471*, 487*, 488* (electives)

Strongly Recommended Electives:
Biology 111, 112
More Mathematics, particularly 223, 224, 225
More Physics, particularly 210 and 310
More Biology, for students interested in biochemistry and medicine
Computer Science 111

*May be included in the nine major courses required for graduation and may be needed for ACS certification.

Course Descriptions

101. Survey of Chemistry
A survey course designed for non-science concentrators which considers the historical and philosophical developments in chemistry, as well as the application of chemical principles to physical phenomena and social issues. Topics include the development of the atomic theory of matter, atomic structure, chemical bonding, thermodynamics, the chemistry of life (organic and biochemistry), and nuclear energy. Some elementary mathematics will be used. Three lectures and one laboratory each week. Partially fulfills the College laboratory science requirement. This course does not satisfy requirements for the chemistry major or minor.

One course credit, each semester.

102. Topics in Chemistry
A study of topics of current interest in chemistry. Topics and prerequisites will vary and will be announced prior to registration. does not count towards the chemistry major or minor; however students are advised that it will count towards the 11 course maximum. Does not count towards the laboratory science distribution requirement.

One-half or one course credit, either or both semesters.

111. General Chemistry
The introductory course for science concentrators. Topics include atomic theory, stoichiometry, thermochemistry, equilibrium, gas laws, states of matter, solutions, atomic structure, and acid/base chemistry. The laboratory, which emphasizes the basic principles discussed in lecture, includes significant synthetic and analytical work. Three lectures and one laboratory each week.

One course credit, fall semester.

221. Organic Chemistry I
A study of the structure and reactions of simple organic compounds. Included as topics are molecular conformations, stereochemistry, and a discussion of some types of modern spectroscopic techniques. The laboratory work emphasizes techniques frequently used by the organic chemist, including distillation, crystallization, sublimation, chromatography and spectroscopy. Three lectures and one laboratory each week. *Prerequisite: Chemistry 111.*

One course credit, spring semester.

222. Organic Chemistry II
Characteristic reactions and syntheses of organic molecules will be covered in this course. Spectroscopic techniques not covered in Chemistry 221 will also be surveyed. Emphasis is placed on the utility of organic chemistry in today's world; class discussions and laboratory work will present many biologically interesting illustrations. Also included is an introduction to the use of the chemical literature. Three lectures and one laboratory each week. *Prerequisite: Chemistry 221.*

One course credit, fall semester.

231. Quantitative Chemistry
Detailed consideration of chemical equilibrium, thermodynamics and redox processes. The laboratory will focus on quantitative methods of analysis and on measurement statistics. Spreadsheets will be introduced and utilized. Three lectures and one laboratory each week for the first half of the semester. *Prerequisites: Chemistry 111, Mathematics 111.*

One-half course credit, spring semester.

241. Descriptive Chemistry
A study of the bonding and reaction chemistry of inorganic species, reaction kinetics and radiochemistry. The laboratory will feature a multi-week project involving the synthesis, characterization and chemistry of an inorganic compound, as well as experiments in descriptive inorganic chemistry. Three lectures and one laboratory each week for the second-half of the semester. *Prerequisite: Chemistry 222 or permission of instructor.*

One-half course credit, spring semester.

331. Advanced Analytical Chemistry

An integrated survey of the application of instrumental methods (chromatography, electrochemistry, and spectroscopy) to the analysis of chemical systems. Statistical methods of data analysis will also be covered. Extensive use is made of examples taken from the current literature. The laboratory emphasizes instrumental methods of separation and analysis. Three lectures and one laboratory each week. *Prerequisite: Chemistry 231.*

One course credit, spring semester.

351. Physical Chemistry I
An introduction to quantum mechanics through the study of exactly soluble models of chemical significance is followed by a statistical mechanical development of chemical thermodynamics. Topics include the postulates of quantum mechanics, the Schrodinger equation, the Heisenberg uncertainty principle, equations of state, partition functions, laws of thermodynamics, and the thermodynamics of ideal and non-ideal solutions. The laboratory applies concepts studied in lecture and emphasizes laboratory report writing skills. Three lectures and one laboratory each week. *Prerequisites: Chemistry 231, Physics 112 or 113, Mathematics 112.*

One course credit, fall semester.

361. Biochemistry
Basic chemical concepts such as intermolecular forces, equilibria, energetics, and reaction mechanisms will be used to study biological systems. The class will be divided into three major foci: biomolecular structures, metabolism, and information transfer. The laboratory will familiarize students with common biochemical techniques and will integrate current areas of biochemical research. Three lectures and one laboratory each week. *Prerequisites: Chemistry 222; 231 or concurrent registration in 231, or with permission of the instructor.*

One course credit, spring semester.

421. Advanced Topics in Organic Chemistry
Topics covered vary from year to year. Examples of recent topics include: advanced synthesis, medicinal chemistry, and physical organic chemistry. *Prerequisite: Chemistry 222.*

One-half course credit, either semester.

431. Advanced Laboratory
A laboratory-oriented presentation of various advanced concepts in chemical instrumentation. Experiments dealing with basic analog and digital electronics will stress measurement techniques and the construction and testing of simple, yet useful, circuits. The use of laboratory computers will be considered, with emphasis on data collection (interfacing) and manipulation. These topics are then integrated into discussion and experiments dealing with instrumental analysis (electrochemistry, spectroscopy). Individual projects will involve the construction/characterization of analytical instruments. One discussion and one laboratory each week. *Prerequisite: Chemistry 331 or permission of instructor.*

One-half course credit, fall semester.

441. Advanced Inorganic Chemistry
A survey of the periodic table emphasizing the applications of modern structural principles, kinetics, and thermodynamics to inorganic systems. Descriptive treatment of selected elements and families included. Three lectures each week. The laboratory experiments emphasize the synthesis and characterization of air-sensitive compounds. Three lectures and one laboratory each week. *Prerequisites: Chemistry 241 and 351.*

One course credit, fall semester.

451. Physical Chemistry II
An advanced study of quantum mechanics beyond 351, including molecular structure, group theory, molecular spectroscopy and advanced concepts in chemical bonding. It is very important that students who are interested in attending graduate school in chemistry or biochemistry take this course. Laboratory experiments reflect topics discussed in lecture. *Prerequisite: Chemistry 351.*

One-half course credit, spring semester.

452. Advanced Physical Chemistry
This course offers further study of special topics in physical chemistry beyond the topics covered in Chemistry 351 and 451. Examples of recent topics include chemical kinetics, molecular spectroscopy, computational quantum mechanics, and lasers in spectroscopy and chemistry. Laboratory experiments reflect topics discussed in lecture. *Prerequisite: Chemistry 451 or permission of instructor.*

One-half course credit, spring semester.

461. Advanced Topics in Biochemistry
Topics vary from year to year. Examples of recent topics include: the chemistry of cancer, determing structures of biomolecules, the RNA world, and the mechanisms of enzyme action.

One-half course credit, either semester.

471. Special Topics in Chemistry
Focused study of topics of current chemical interest for advanced students; topics vary from year to year and are announced prior to registration for each semester. *Prerequisites: Vary with each individual topic; watch for course announcement prior to pre-registration.*

One-half course credit, either or both semesters.

487, 488. Special Problems
Individual laboratory or library research projects under the supervision of individual faculty on selected problems for qualified students. Students must have prior consent of faculty member to enroll in this course.

One-half or one course credit, either or both semesters.

Department of Mathematics and Computer Science

Faculty: J.D. Phillips (chair), M. Axtell, R. Foote, D. Maharry, E. Poffald, P. Thompson, W. Turner, C. Westphal

The Department of Mathematics and Computer Science has as its goals:

- To give all students who take mathematics courses a sense of the nature of mathematics and its place in society;

- To give students in departments which use mathematics or computer science adequate understanding to know when to use a particular result as well as how to use it;

- To give our majors and minors an understanding of mathematics and computer science, their nature, and uses, to prepare students to become effective users of mathematics and computer science in their careers;

- To prepare future high school teachers of mathematics;

- To give our students interested in continuing to graduate study in mathematics, statistics, or computer science an adequate preparation to succeed in that study.

Mathematics

Mathematics majors may opt for either the Pure Mathematics Major or the Computational Mathematics Major. There is a great deal of overlap between these two choices.

Requirements for the Pure Mathematics Major:

1) Calculus I (111), Calculus II (112), Linear Algebra (223), Abstract Algebra (331)

2) Real Analysis (333) or Topology (341)

3) Senior Seminar (400)

4) Electives (excluding Mathematics 003, 106, 107, 108, and 217) to reach the Department's 9-credit minimum

Requirements for the Computational Mathematics Major:

1) Calculus I (111), Calculus II (112), Linear Algebra (223), and Abstract Algebra (331)

2) Differential Equations (224)

3) Numerical Methods (337) or Topics in Computational Mathematics (338)

4) One additional course from 219, 226, 314, 337, and 338

5) Senior Seminar (400)

6) Electives (excluding Mathematics 003, 106, 107, 108, and 217) to reach the Department's 9-credit minimum

Incoming freshmen interested in pursuing mathematics at Wabash College will typically take Math 111 or Math 112 in the fall (depending on placement) and Math 112 or Math 223 in the spring. Course choices in the fall of the sophomore year will usually depend on the direction the student sees himself headed. Students should plan on taking Math 331 in the spring of their sophomore year. It is a good idea for all mathematics students to contact one of the mathematics professors.

Requirements for the Minor: Five or more course credits, including Mathematics 111, 112, 223, excluding Mathematics 003, 106, 107, and 108. Mathematics 003 should not be used in an area concentration.

Advanced Placement Credit: Students should take the BC Advanced Placement exam (as opposed to the AB exam) if they have covered the appropriate material. If placed into Mathematics 112 on the basis of the Advanced Placement exam or the departmental exam, credit will be given for Mathematics 111 upon successful completion of Mathematics 112 with a grade of B- or better. If placed into a more advanced course, credit will be given for Mathematics 111 and 112 upon successful completion of Mathematics 224 or 225 with a grade of B- or better.

Course Descriptions

003. Pre-calculus
This course is intended solely for those students who wish to take calculus, but whose high school background is inadequate to do so immediately. Topics covered include review of algebra (solving equations and inequalities, simplification of algebraic expressions) and properties of elementary functions (polynomials, rational, exponential, logarithmic and trigonometric functions) with special emphasis on graphing these functions. For students who desire a distribution credit in mathematics but do not wish to take calculus, Mathematics 107, 106, and 108 are recommended. Mathematics 003 cannot be used for distribution. Admission to Mathematics 003 is by permission of the department chair only.

One course credit, fall semester. Introductory.

106. Topics in Contemporary Mathematics
A reflective examination of basic mathematical ideas. Through participation and discovery, students will consider an articulation of mathematics that focuses on patterns, abstraction, and inquiry. Topics will vary, but could include logic, Euclidean geometry, algorithms, etc. This course does not count towards the major or minor in mathematics. No prerequisite.

One course credit.

107. Statistics: Concepts and Controversies
The course introduces statistics as a liberal arts discipline. It focuses on statistical ideas and their relevance to public policy and to the sciences, from medicine to sociology. The emphasis is on statistical reasoning, rather than statistical theory. The course covers reliable data generation, data summarization, and the classical approach to drawing conclusions from data (statistical inference). This course does not count towards the major or minor in mathematics. Students who have taken calculus are encouraged to take Mathematics 217 or Mathematics 227 instead of Mathematics 107.

One course credit. Introductory.

108. Introduction to Discrete Structures
An introduction to discrete mathematics for students not planning to major in mathematics. Topics include sets and logic, proof methods, counting arguments, recurrence relations, graphs, and trees. This course may be used to meet the mathematics requirement for the computer science minor. However, it does not count toward the mathematics major or minor. Students may not present both mathematics 108 and 219 for credit toward graduation. *Prerequisite: Good background in high school mathematics.*

One course credit, fall semester. Introductory.

111. Calculus I
Basic calculus of one variable from an intuitive point of view. Topics include limits, continuity, derivatives and integrals of the elementary functions, Fundamental Theorem of Calculus, and applications. The focus is on understanding basic concepts and gaining basic computational skills. *Prerequisite: Departmental placement examination.*

One course credit, each semester. Introductory.

112. Calculus II
A continuation of Mathematics 111. Numerical and symbolic techniques of integration, applications of integration, an introduction to partial derivatives and multiple integrals, sequences and series, and Taylor's Theorem. *Prerequisite: Mathematics 111, departmental placement examination, AP examination, or permission of the department.*

One course credit, each semester. Introductory.

217. Introduction to Statistics
A first course in statistics that covers techniques for summarizing data probability, random variables, confidence intervals, and the classical approach to the testing of hypotheses, including z-tests on means and proportions for one and two groups, t-tests on means for one and two groups, F-tests on means for several groups, chi square goodness-of-fit tests, and some other nonparametric tests. A mathematical treatment is given for all the distributions involved in these

standard tests. This course counts towards the mathematics minor and is particularly appropriate for students majoring in the natural or social sciences. It does not count towards the mathematics major. Mathematics majors interested in statistics should take Mathematics 227, possibly followed by Mathematics 228. *Prerequisite: Mathematics 111 or equivalent.*

One course credit, spring semester. Intermediate.

219. Combinatorics
This course is an introduction to combinatorial reasoning. Topics include graphs, circuits in graphs, graph coloring, trees, counting principles, generating functions, and recurrence relations. *Prerequisite: Mathematics 223 or consent of instructor. Students may not present both Mathematics 108 and Mathematics 219 for credit towards graduation.*

One course credit, spring semester, 2006–2007 and alternate years. Intermediate.

221. Foundations of Geometry
A development of Euclidean and non-Euclidean geometries from a modern viewpoint. *Prerequisite: Mathematics 112 or permission of the instructor.*

One course credit, spring semester, alternate years. Intermediate.

222. Theory of Numbers
A study of elementary number theory. Topics include divisibility, congruences, properties of prime numbers, number theoretic functions, diophantine equations, and additional selected topics. *Prerequisite: Mathematics 112 or consent of the instructor.*

One course credit, fall semester. Intermediate.

223. Elementary Linear Algebra
An introduction to linear mathematics. Linear systems of equations, matrices, determinants, vector spaces, bases and dimension, function spaces, linear transformations, eigenvalues and eigenvectors, inner products, and applications. An important aspect of the course is to introduce the student to abstract thinking and proofs. *Prerequisite: Mathematics 112, departmental placement examination, AP examination, or permission of the department.*

One course credit, each semester. Intermediate.

224. Elementary Differential Equations
Introduction to ordinary differential equations. Special solution techniques and some theory for first-order and linear equations including integrating factors, constant coefficients, undetermined coefficients, variation of parameters, power series solutions, Laplace transforms, and systems of differential equations, applications. *Prerequisite: Mathematics 112 and 223.*

One course credit, spring semester. Intermediate.

225. Multivariable Calculus

Calculus in higher dimensions. Limits, continuity, differentiability, directional derivatives, constrained and unconstrained optimization, geometry of curves, multiple integrals, general coordinate systems, path and surface integrals, vector calculus, theorems of Green and Stokes, applications. *Prerequisite: Mathematics 112 and 223.*

One course credit, fall semester. Intermediate.

226. Operations Research
Linear and nonlinear optimization, linear programming, integer programming, duality, combinatorics, the simplex method and related algorithms, game theory, decision analysis, Markov chains, queuing theory. *Prerequisite: Mathematics 223 or consent of the instructor.*

One course credit, spring semester, 2005-2006 and alternate years. Intermediate.

227, 228. Probability and Statistics
General theory and application of probability and statistics, including probability for finite sample spaces, discrete and continuous distributions, marginal and conditional distributions, mathematical expectation, variance, moment-generating functions, functions of random variables, the Central Limit Theorem, sampling distributions, the methods of estimation and their application, hypothesis testing, regression and correlation. *Prerequisite: Mathematics 112 (227 is a prerequisite for 228).*

One course credit, Mathematics 227 (fall semester), Mathematics 228 (spring semester). Intermediate.

314. Modeling with Differential Equations
A course to develop the basic skills of formulation, simplification, and analysis of mathematical models for describing and predicting phenomena in the natural and social sciences, with special emphasis in modeling with differential equations. Topics may be taken from fields such as physics, chemistry, biology, psychology, and political science. *Prerequisite: Mathematics 224.*

One course credit, fall semester, 2006-2007 and alternate years. Advanced.

324. Topics in Differential Equations
A second course in differential equations, offering study of special topics in more depth or beyond those covered in Mathematics 224. Topics may include existence and uniqueness theory, stability theory, Green's functions, dynamical systems, partial differential equations, and applications of differential equations. *Prerequisite: Mathematics 224 or consent of the instructor.*

One course credit, fall semester, 2005-2006 and alternate years. Advanced.

331, 332. Abstract Algebra
A first course in higher abstract mathematics. Emphasis is placed on writing proofs. Topics in Mathematics 331 include groups, rings, fields, and applications. Topics in Mathematics 332 include the above and ideals, integral domains, algebraic properties of integers, polynomials over

algebraic structures, vector spaces and modules. *Prerequisite: Mathematics 223 or consent of the instructor (331 is a prerequisite for 332).*

One course credit. Mathematics 331 spring semester. Mathematics 332 offered fall semester in 2004–2005 and alternate years. Advanced.

333, 334. Introduction to Functions of a Real Variable
A first course in the foundations of modern analysis. Topics include set theory, the real numbers, the topology of Cartesian spaces, convergence, continuous functions, sequences of continuous functions, the Stone-Weierstrass approximation theorem, differentiation, integration, and infinite series. (*333 is a prerequisite for 334*).

One course credit. Mathematics 333 fall semester. Mathematics 334 offered spring semester in 2004-2005 and alternate years. Advanced.

337. Introduction to Numerical Analysis [Same as CSC 337]
This course will address topics such as solution of non-linear equations in one variable, interpolation, approximation, differentiation, integration, difference equations, differential equations and their applications, boundary value problems, linear systems, matrices, and optimization. *Prerequisite: Consent of instructor.*

One course credit, fall semester, 2004-2005 and alternate years. Advanced.

338. Topics in Computational Mathematics [Same as CSC 338]
A course to develop mathematical and computational techniques in areas of mathematics or interdisciplinary study in which computation plays a central and essential role. Topics vary by semester but may include computational geometry, computer algebra, scientific computing, and symbolic computation. *Prerequisite: Computer Science 111.*

One course credit, fall semester, 2005-2006 and alternate years. Advanced.

341. Topology
A study of elementary topology. Topics discussed will include topologies, separation axioms, connectedness, compactness, continuity, and metric spaces. *Prerequisite: Mathematics 223 or consent of the instructor.*

One course credit, fall semester, 2005-2006 and alternate years. Advanced.

344. Complex Analysis
Analytic functions, mapping of elementary functions, integrals, residue theory, conformal mapping. *Prerequisite: Mathematics 223 or consent of the instructor.*

One course credit, spring semester, 2004-2005 and alternate years. Advanced.

377. Special Topics in Mathematics

This course is designed for the treatment of material outside the regular offerings of the department. For a given semester the course content and other particulars will be announced before advance registration for that semester.

One-half or one credit available each semester it is offered. Level varies, will be announced with course description the semester it is offered.

387, 388. Independent Study
Directed reading and research on special topics for qualified students. May be repeated for credit. *Prerequisite: Permission of the department. Credit will be based upon results as judged by the department chair.*

One-half or one credit available each semester. Level varies (intermediate or advanced), determined in consultation with instructor.

400. Seminar
Topics in the history and foundations of mathematics, the special emphasis varying from year to year. Every student will be expected to write a term paper. Usually taken by mathematics majors in the spring semester of the senior year. Admission in other cases is by permission of the department chair.

One-half course credit, spring semester. Advanced.

Computer Science

No major is offered.

Requirements for the minor: The requirements for a minor in computer science are five courses in computer science and one course in mathematics. The computer science courses must be: Computer Science 111 and 112 and three other Computer Science courses. The mathematics course must be Mathematics 108 or 219.

Course Descriptions

101. Introduction to Computer Science
An introduction to the field of computer science as the study of algorithmic process. Students will study the history of the field as well as issues currently confronting the computer science community including ethical issues raised by a rapidly changing technology. Students will learn fundamental concepts of computer science such as computer architecture, data representation, and the issues of computability. Students will engage in hands-on algorithm-building activities and some basic programming exercises. *Prerequisite: None*.

One course credit, fall semester. Distribution in Natural Science and Mathematics or Quantitative Skills.

111. Introduction to Programming
An introduction to programming in a higher-level, general-purpose language (currently Java). Programming topics include primitive data types, simple data types such as arrays, program constructs such as conditionals, loops and procedures, in an object-oriented context. Applications are chosen from areas such as graphics, simulation, and file processing. *Prerequisite: Computer Science 101 or equivalent programming background.*

One course credit. Offered every semester. Distribution in Natural Science and Mathematics or Quantitative skills. (Note: Computer Science 111 does not count as a laboratory science.)

112. Advanced Programming
A variety of topics that are important in developing large-scale software. Object oriented programming in a language such as C++. Dynamic data structures such as lists, queues, and stacks. An introduction to a rigorous analysis of the efficiency of an algorithm. Advanced algorithms such as Quicksort, mergesort, and the use of hash tables. An introduction to using the Unix operating system and Unix tools for software development such as Make. *Prerequisite: Computer Science 111 or equivalent programming background.*

One course credit, fall semester.

211. Introduction to Data Structures
An introduction to more advanced abstract data types such as lists, sets, trees, including balanced trees, and graphs. Algorithms for traversing, searching, determining connectivity, and so forth. An in-depth study of, and analysis of, the algorithms used to implement these structures. *Prerequisite: Computer Science 112.*

One course credit, spring semester.

271. Special Topics in Computer Science
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester the course content and other particulars will be announced before registration for that semester.

One-half or one credit available each semester it is offered: offered irregularly.

311. Introduction to Machine Organization
A study of the various layers at which a machine can be studied, including higher-level languages, assembly language, machine language, and digital circuits. Data representation. A comparison of RISC and CISC architectures. Some programming in a representative assembly language. Issues of cross-language programming. *Prerequisite: Computer Science 112.*

One course credit, fall semester, 2004-2005 and alternate years.

321. Programming Languages
A study of the paradigms of programming languages, including procedural languages such as Pascal or ‘C', object-oriented languages such as C++ or Smalltalk, functional languages such as

ML or Scheme, logic-oriented languages such as Prolog, and concurrency such as in Ada. Consideration of how concepts are implemented, such as modules, parameter passing, function evaluation, data types and type checking, memory management, exception handling, and threads. *Prerequisite: Computer Science 112.*

One course credit, spring semester, 2004-2005 and alternate years.

331. Analysis of Algorithms
Advanced topics and problems in analyzing algorithms. Algorithms involving structures such as sequences, sets, and graphs, and topics such as geometric and numeric algorithms. An introduction to the question of P=NP and NP-Complete problems. Parallel algorithms. *Prerequisite: Computer Science 112 and Mathematics 108 or 219.*

One course credit, spring semester, 2005-2006 and alternate years.

337. Introduction to Numerical Analysis [Same as MAT 337]
This course will address topics such as solution of non-linear equations in one variable, interpolation, approximation, differentiation, integration, difference equations, differential equations and their applications, boundary value problems, linear systems, matrices, and optimization. *Prerequisite: Consent of instructor.*

One course credit, fall semester, 2004-2005 and alternate years. Advanced.

338. Topics in Computational Mathematics [Same as MAT 338]
A course to develop mathematical and computational techniques in areas of mathematics or interdisciplinary study in which computation plays a central and essential role. Topics vary by semester but may include computational geometry, computer algebra, scientific computing, and symbolic computation. *Prerequisite: Computer Science 111.*

One course credit, fall semester, 2005-2006 and alternate years. Advanced.

341. Introduction to Automata, Computability, and Formal Languages.
An introduction to theoretical computer science. Finite state machines and regular expressions. Context-free languages and push-down automata. Turing machines, effective computability, and the Halting Problem. *Prerequisite: Computer Science 111 and Mathematics 108 or 219.*

One course credit, fall semester, 2005-2006 and alternate years.

387, 388. Independent Study
Directed study on special topics for qualified students. May be repeated for credit. *Prerequisite: Permission of the instructor.*

One or one-half course credit each semester.

Department of Physics

Faculty: D. Krause (chair), J. Brown, R. Hansen

Physics is the study of the fundamental laws that govern our universe. Our curriculum is designed to give our students a solid foundation for understanding these laws and how they were uncovered. The language that best expresses these laws is mathematical so there are a significant number of mathematics courses, which serve as prerequisites for our courses. However, since physics describes the real world, our curriculum also incorporates a significant laboratory component to ensure that our students will learn how to interrogate Nature and understand the answers it gives. Only by balancing theoretical concepts with experimental reality can one reach a more complete understanding of the world.

Our physics majors and minors will master valuable analysis and problem-solving skills, which can be applied to wide variety of situations beyond physics. By integrating these skills with their liberal arts experiences, our students are prepared for a vast spectrum of careers. Recent graduates have gone on to work in physics research, engineering, computer programming, teaching, environmental studies, law, business, and other fields.

For **Senior Comprehensives**, majors must pass an exam which requires them to demonstrate a coherent understanding of all the major areas of physics covered in the required courses, including computational and laboratory methods, and the ability to apply this understanding to solve specific problems.

Requirements for a Major: Nine course credits in physics. These must include Physics 111, 113, 210, 310, 314, 315, 381 (taken at least two semesters), and one additional physics course credit (excluding Physics 101 and Physics 112 which do not count toward the major). Students accepted to a 3-2 engineering program may substitute Chemistry 111 for the one elective physics course. Those planning to go on to graduate school in physics should also plan to take Physics 230 and 316.

In addition, mathematics courses that are prerequisites or co-requisites for physics courses are Mathematics 111, 112, 223, 224, and 225. Although not required, Computer Science 111 is also highly recommended, and Mathematics 324 and 344 are useful.

Since physics is a hierarchical subject, it is important to take Physics 111 and 113 during the freshman year if one wishes to major in physics. Below is a possible schedule of how one might fulfill all the necessary requirements:

	Fall Semester	Spring Semester
Freshman	Physics 111 Mathematics 111	Physics 113 Mathematics 112
Sophomore	Physics 114 Mathematics 223	Physics 210 Mathematics 224

Junior	Physics 310 Physics 381 Mathematics 225	Physics 314 Physics 381
Senior	Physics 315	Physics 220, 230, or 316

Requirements for a Minor: Five courses in physics. These must include Physics 111, 113, 114, 210, and one additional physics course (excluding Physics 101 and Physics 112). Mathematics prerequisites (or co-requisites) are Mathematics 111, 112, and 223.

Course Descriptions

101. Astronomy: Fundamentals and Frontiers
An introductory course intended for the non-science liberal arts student. Historical and philosophical ideas will be stressed as well as the experimental concepts and methods used in astronomy. A good working knowledge of algebra, plane geometry, and trigonometry is required. Satisfies half of the laboratory science requirement. Three class periods and one laboratory each week.

One course credit, fall semester.

111. General Physics I
An introduction to classical mechanics for physics and other science majors. Topics include Newton's laws of motion, conservation laws, and rotational dynamics. Three class periods and one laboratory each week. *Prerequisite: Mathematics 111 (or concurrent registration) or permission of instructor.*

One course credit, fall semester.

112. General Physics II for Science Majors
Selected topics in wave physics, optics, and electromagnetism for students not planning to take additional courses in the department. Students intending to major or minor in physics must take Physics 113 instead of Physics 112. Three class periods and one laboratory each week. *Prerequisite: Physics 111.*

One course credit, spring semester.

113. General Physics II for Physics Majors and Minors
An introduction to thermal physics and special relativity. Topics include the laws of thermodynamics, statistical nature of entropy, Lorentz transformations, equivalence of mass and energy. (While this course is required for a physics major or minor, it may be taken by an interested student who meets the prerequisites.) Three class periods and one laboratory each week. *Prerequisite: Physics 111 and Mathematics 112 (or concurrent registration).*

One course credit, spring semester.

114. General Physics III
An introduction to electrodynamics, optics, and wave physics. Three class periods and one laboratory each week. *Prerequisite: Physics 113 and Mathematics 112.*

One course credit, fall semester.

210. Modern Physics
Historical introduction to quantum theory with applications to atomic, solid state, nuclear, and particle physics. Three class periods and one laboratory each week. *Prerequisite: Physics 114 and Mathematics 223 (or concurrent registration).*

One course credit, spring semester.

220. Electronics
Introduction to analog and digital electronics. Fundamentals of DC and AC circuits, transistors, and amplifiers will be covered. Includes 1 lab per week. *Prerequisite: Physics 114.*

One credit course, spring semester, offered alternate years.

230. Thermal Physics
Introduction to thermal and statistical physics. The laws of thermodynamics are studied from microscopic and macroscopic perspectives. Quantum statistical mechanics will be developed and applied to blackbody radiation, fermionic and bosonic systems. *Prerequisite: Physics 210.*

One credit course, spring semester, offered alternate years.

277, 278. Special Topics
Special interest course. *Prerequisite: Permission of instructor.*

One or one-half course credit each semester.

287, 288. Independent Study
Independent study. *Prerequisite: Permission of instructor.*

One or one-half course credit each semester.

310. Classical Mechanics
Advanced topics in classical mechanics, including harmonic motion and Lagrangian mechanics. *Prerequisite: Physics 114 (or permission of instructor) and mathematics 224.*

One course credit, fall semester.

314. Electrodynamics
Advanced explorations in understanding and applying Maxwell's equations. *Prerequisites: Physics 114 and Mathematics 224 and 225.*

One course credit, spring semester.

315. Quantum Mechanics
Introduction to quantum mechanics. Topics include Dirac notation, postulates of quantum mechanics, and applications to important physical systems. *Prerequisites: Physics 210 and Mathematics 223 and 224.*

One course credit, fall semester.

316. Advanced Topics in Quantum Mechanics
Applications of quantum mechanics, including the general theory of angular momentum, identical particle systems, perturbation theory, atom-photon interactions, and Bell's theorem. *Prerequisite: Physics 315.*

One course credit, spring semester.

381. Advanced Laboratory
Labs investigating various topics in physics. Advanced measurement and data analysis techniques will be studied. *Prerequisite: Physics 210.*

One-half course credit, each semester, may be taken multiple times.