

Chemistry and Physics

Department: Chemistry and Physics

Department Chair: A. Thapaliya

Department Members: H. Florian, K. Shumba, A. Thapaliya, S. Wilder

Major: Chemistry (Tracks: Standard, Environmental Science, Biochemistry, and Industry/Graduate School)

Minors: Chemistry, Biochemistry, and Biomedical Physics

Related Major: Neuroscience

Pre-Professional Programs: Pre-Dental, Pre-Forensic Science, Pre-Medical, Pre-Medical Laboratory Science (See Medical Laboratory Science section of the catalog), Pre-Optometry, Pre-Pharmacy, Pre-Physician Assistant, Pre-Veterinary

Cooperative Programs: Health-related Professions: Medical Laboratory Science, Pharmacy, Public Health

The undergraduate program in chemistry introduces students to the collection of chemical principles, theories, and facts that have evolved in the more than 200 years that chemistry has existed as a science. The program gives students an opportunity to collect, analyze, and critically evaluate data in the laboratory, and to appreciate the relationship of factual data to scientific purposes, laws, and theories. The body of knowledge acquired and the experience gained in the use of modern instrumentation to collect and to analyze data, prepares students for further study in chemistry at the graduate level, for the pursuit of a career in industrial chemistry or in a health science, and also serve as a chemistry knowledge base necessary for the study of other sciences, including medicine, pharmacy, optometry, biology, toxicology, and environmental science. Finally it is the aim of the department to help the student better understand the natural and the synthetic products and the processes that are encountered in everyday life, thus to satisfy the student's curiosity about the physical world.

The physics program at Franklin College is designed to provide students with a working knowledge of physics to support and enhance their study in their major discipline. The program provides experiences that enable students to understand the nature of physics and to use physics as a problem-solving tool. The program concentrates on the development of critical thinking.

The students who minor in biomedical physics and chemistry will be well supported for their major course of study and better prepared for success in graduate or professional schools, or immediate employment. Student abilities that are fostered by this curriculum include: understanding the nature of scientific reasoning in considerable depth, understanding the concepts and methods of physics and chemistry, and being able to synthesize information from basic topics and applying it to solve real world problems.

Chemistry Major

Completion of the Chemistry major will require students to complete **one** of the four following tracks (standard, environmental, graduate school/industry, and biochemistry) or a Cooperative 3+ Health Professions Program in Chemistry. All **tracks** will share a common core and each track will have additional biology, chemistry, and related field requirements. Cooperative 3+ Programs in Chemistry have a common core (different from the core for the other chemistry tracks) and additional specific requirements for each cooperative program.

Core Requirements (required for all chemistry tracks)

CHE 121 General Chemistry I
CHE 122 General Chemistry II
CHE 123 General Chemistry I Lab
CHE 124 General Chemistry II Lab
CHE 221 Organic Chemistry I
CHE 222 Organic Chemistry II
CHE 223 Organic Chemistry Lab I
CHE 224 Organic Chemistry Lab II
CHE 227 Analytical Chemistry
CHE 341 Physical Chemistry I
CHE 343 Physical Chemistry Lab I
CHE 472 Chemistry Seminar
CHE 499 Senior Competency Practicum

Related Field Requirements for Chemistry Major (required for all chemistry tracks)

A grade of D- or better satisfies the requirement for successful completion of the related field courses in biology and math. A grade of C- or better satisfies the requirement for successful completion of the related field courses in physics.

BIO 134 Principles of Biology
BIO 140 Cell Biology
MAT 135 Calculus
MAT 140 Intro to Mathematical Sciences
PHY 201 or 211 & 203 General Physics I and Lab (*not required for Nursing*)
PHY 202 or 212 & 204 General Physics II and Lab (*not required for Nursing*)

Chemistry Professional Development Program/Senior Year Experience

All Chemistry majors must complete the requirements of either Plan A or Plan B.

Plan A **BIO/CHE 390** Professional Development Planning

SNR 489 Professional Development Research Experience

To receive permission to do Plan A, students must complete an SNR 489 proposal sponsored by a faculty member who will oversee their project. This proposal must be approved by the Chemistry and Physics Department prior to the start of the project. SNR 489 must be completed during the summer prior to or during the senior year. BIO/CHE 390 is a prerequisite for SNR 489.

Plan B **BIO/CHE 390** Professional Development Planning

INT XXX Internship

(INT XXX must be completed during the summer prior to or during the senior year. CHE 390 is a prerequisite for INT XXX.)

Standard Chemistry Track

In addition to the core and PDP/SYE requirements, students must take the following:

A minimum of six credit hours from the following options

Note: CHE 375 or CHE 490 may count toward the 6 hours, but not both.

- BIO/CHE 334** Biochemistry
- BIO/CHE 392** Techniques in Biotechnology and Biochemistry
- CHE 300** Topics Course
- CHE 322** Spectroscopic Methods of Analysis
- CHE 342** Quantum Chemistry and Spectroscopy
- CHE 344** Quantum Chemistry and Spectroscopy Lab
- CHE 375** Undergraduate Research
- CHE 434** Advanced Inorganic Chemistry
- CHE 448** Instrumental Analysis
- CHE 490** Independent Study

Environmental Science Track

In addition to the core and PDP/SYE requirements, students must take the following:

- BIO 240** Ecology
- BIO 320** Conservation Biology
- ECO 121** Principles of Microeconomics OR **ECO 123** Principles of Macroeconomics
- ENG 228** Advanced Composition
- ESC 118** Earth Science
- POL 110** American National Government
- POL 336** Introduction to Public Policy

Two of the following courses

Note: CHE 375 or CHE 490 may count toward the two chemistry courses, but not both.

- BIO/CHE 334** Biochemistry
- CHE 342** Quantum Chemistry and Spectroscopy
- CHE 375** Undergraduate Research
- CHE 448** Instrumental Analysis
- CHE 490** Independent Study – Research

Recommended Courses

- BIO 221** Botany
- BIO 322** Ornithology
- BIO 335** Plant Communities
- BIO 373** Microbiology
- BIO 380** Field Biology
- CMP 130** Introduction to Computing
- REL 210** Religion and the Environment
- SOC 118** Introduction to Sociology
- SOC/NPL 222** Social Problems & Nonprofit Responses

Industry and Graduate School Track

In addition to the core and PDP/SYE requirements, students must take the following:

BIO/CHE 334 Biochemistry
CHE 342 Quantum Chemistry and Spectroscopy
MAT 142 Calculus II

One of the following courses

CHE 300 Topics Course
CHE 322 Spectroscopic Methods of Analysis
CHE 344 Quantum Chemistry and Spectroscopy Lab
CHE 375 Undergraduate Research
BIO/CHE 392 Techniques in Biotechnology and Biochemistry
CHE 434 Advanced Inorganic Chemistry
CHE 448 Instrumental Analysis
CHE 490 Independent Study

Biochemistry Track

In addition to the core and PDP/SYE requirements, students must take the following:

BIO/CHE 334 Biochemistry
BIO 350 Genetics
BIO/CHE 392 Techniques in Biotechnology and Biochemistry
MAT 142 Calculus II OR **MAT 224** Basic Applied Statistics

One of the following courses

CHE 342 Quantum Chemistry and Spectroscopy
CHE/BIO 375 Undergraduate Research
CHE 448 Instrumental Analysis

One of the following courses

BIO 215 Human Anatomy and Physiology II
BIO 360 Animal Physiology
BIO 374 Advanced Cell and Molecular Biology
CHE/BIO 375 Undergraduate Research

Note: Students may take CHE 375 or BIO 375, but not both to fulfill the above requirements.

Chemistry and Physics Minors

All courses for the following minors must be completed with a grade of C- or better.

Chemistry Minor

CHE 121 General Chemistry I
CHE 122 General Chemistry II
CHE 123 General Chemistry I Lab
CHE 124 General Chemistry II Lab
CHE 221 Organic Chemistry I
CHE 222 Organic Chemistry II
CHE 223 Organic Chemistry Lab I
CHE 224 Organic Chemistry Lab II
CHE 227 Analytical Chemistry

One of the following options

Option 1: **MAT 135** Calculus
Option 2: **MAT 224** Basic Applied Statistics and **LA 103** Quantitative Reasoning
Option 3: **MAT 224** Basic Applied Statistics and **MAT 131** Introduction to Quantitative Analysis
Option 4: **MAT 224** Basic Applied Statistics (only available if placed into MAT 135)

Note: It is expected that CHE 121 and 123 would be used to satisfy the laboratory science exploratory requirement, and that MAT 135 would replace LA 103 in the prescribed liberal arts curriculum.

Biochemistry Minor

(Available to non-biology and non-chemistry majors only)

BIO 134 Principles of Biology
BIO 140 Cell Biology
BIO/CHE 334 Biochemistry
BIO/CHE 392 Techniques in Biotechnology and Biochemistry
CHE 222 Organic Chemistry II
CHE 224 Organic Chemistry Laboratory II

One of the following courses

BIO 215 Human Anatomy and Physiology II
BIO 360 Animal Physiology
BIO 373 Microbiology

Recommended courses

BIO/CHE 375 Undergraduate Research

Biomedical Physics Minor

PHY 201 or 211 & PHY 203 General Physics I – Algebra or Calculus and Lab

PHY 202 or 212 & PHY 204 General Physics II – Algebra or Calculus and Lab

BIO 210 Human Anatomy and Physiology I

Or

ANAT 210 & ANAT 210L Applied Human Anatomy and Lab

BIO 215 Human Anatomy and Physiology II

Or

ANAT 220 & ANAT 220L Applied Human Physiology and Lab

Two of the following courses:

PHY 355 Ultrasonography

PHY 357 Radiation and Health

PHY 365 Biomedical Optics

Neuroscience Major

Please see separate Neuroscience section in this course catalog.

Pre- Health Professions Programs

Franklin College offers pre-health professions advising to students who are interested in applying to medical school or other health-related professional schools. For more information or questions, please contact the respective faculty member for each profession. Additional information regarding pre-professional program requirements are located on the Franklin College website at <https://franklincollege.edu/major/pre-professional/>.

Pre-Forensic Science—Dr. Florian

Pre-Med (allopathic and osteopathic) and Pre-Podiatry – Dr. Winter

Pre-Pharmacy – Dr. Thapaliya

Pre-Veterinary Medicine and Pre-Dentistry – Dr. O’Neal

Pre-Optometry and Pre-Medical Laboratory Science – Dr. Thapaliya

Pre-Physician Assistant – Dr. Marasco

Cooperative Programs in Health-Related Professions – Chemistry/Physics

All cooperative programs for the chemistry major consist of a common core and specific courses required for each particular program. After completion of three years of college work in one of these programs and fulfilling Franklin College graduation requirements (except total graduation hours), students may receive a bachelor of arts degree from Franklin College upon completing one year at the cooperating institution, for a total of 120 semester hours. Successful completion of the first year in the cooperative program satisfies the senior year experience or internship requirement for the chemistry major ***unless otherwise noted***. Any student following these programs who is not accepted by the cooperating institution after the third year could return to Franklin College and receive a bachelor of arts in chemistry by completing: 1) all of the remaining requirements for the chemistry major standard program, and 2) 120 total semester hours required for graduation. *(Students with a declared enrollment in the aforementioned cooperative programs will be given priority during registration in subsequent semester(s)).*

Cooperative Programs in Health-related Professions

Core Requirements

CHE 121 General Chemistry I
CHE 122 General Chemistry II
CHE 123 General Chemistry I Lab
CHE 124 General Chemistry II Lab
CHE 221 Organic Chemistry I
CHE 222 Organic Chemistry II
CHE 223 Organic Chemistry Lab I
CHE 224 Organic Chemistry Lab II
CHE 227 Analytical Chemistry
CHE 341 Physical Chemistry
CHE 343 Physical Chemistry Lab
CHE 390 Professional Development
CHE 472 Chemistry Seminar
CHE 499 Senior Competency Practicum
MAT 135 Calculus
PHY 201 or 211 & 203 General Physics I and Lab
PHY 202 or 212 & 204 General Physics II and Lab

Chemistry Professional Development Program/Senior Year Experience

Successful completion of the first year in the cooperative program satisfies the senior year experience or internship requirement for the major **unless otherwise noted**.

Plus additional specific program requirements – choose one of the three following programs

A. Medical Laboratory Science at IU Health Methodist Hospital Clinical Laboratory Science Program

BIO 140 Cell Biology
BIO 373 Microbiology
BIO/CHE 334 Biochemistry
Plus 8 Additional Hours of BIO credit
 (preferably BIO 210 and BIO 215 – Human Anatomy and Physiology I and II)
Plus: Completion of the clinical program at IU Health Methodist Hospital

B. Pharmacy at Purdue University or University of Cincinnati

BIO 210 Human Anatomy and Physiology I
BIO 215 Human Anatomy and Physiology II
BIO/CHE 334 Biochemistry
BIO 373 Microbiology
ECO 121 Principles of Microeconomics OR **ECO 123** Principles of Macroeconomics
LA 201 Analyzing Literature
MAT 140 Introduction to Math Sciences
MAT 142 Calculus II
Principles of Immunology - is required by the Purdue University School of Pharmacy. It is offered at FC in spring, even academic years. It also can be taken online during a summer term after completing sophomore year.
Diversity or social ethics is required for the University of Cincinnati.

Recommended**BIO/CHE 392** Techniques in Biotechnology and Biochemistry**Plus completion of 30-35 credits by the end of the first year of pharmacy program****C. Master of Public Health at *IU-I Richard M. Fairbanks School of Public Health*****BIO 134** Principles of Biology**BIO 140** Cell Biology**BIO 210** Human Anatomy and Physiology I**MAT 224** Basic Applied Statistics**Plus completion of one of the following MPH classes in the first year at IU-I****A519** Environmental Health**A609** Air Pollution & Health**A614** Water Quality Management**A661** Environmental Toxicology**D. Bachelor of Science in Nursing at *University of Indianapolis*****BIO 134/134L** Principles of Biology+Lab**BIO 215** Human Anatomy and Physiology II**BIO 373** Microbiology**PHL XXX** Philosophy course or **BIO 225** Bioethics**PSY 117** General Psychology**SOC 118** Introduction to Sociology

Chemistry Course Descriptions

CHE 001 Laboratory Assistant	1 credit hour

The purpose of this course is to give practical experience working in a chemistry laboratory. Student will gain this experience by preparing labs and setting up instruments for the chemistry labs. Counts as an activity credit.

CHE 112 Introductory Chemistry	4 credit hours
Fall or Spring	Scientific Thinking exploratory

For non-science majors only. Introduction to the theories, concepts, and techniques of chemistry which have led to a modern understanding of the behavior of matter. Complementary, weekly laboratory exercises are designed to demonstrate practical applications of modern chemistry in everyday life. Although mathematics is not stressed, proficiency in high school algebra is expected. *Consent of instructor is required for a student who has already earned credit for CHE 121.*

CHE 121 General Chemistry I	5 credit hours
Fall	Scientific Thinking exploratory
	Prereq: Two years of high school mathematics, one year of high school chemistry, or consent of instructor; Coreq: CHE 123

An introductory course in college chemistry. Stoichiometry, thermochemistry, atomic theory, chemical bonding, states of matter and phase changes, properties of selected elements and compounds, and solutions. Four hours lecture.

CHE 122 General Chemistry II	5 credit hours
Spring	Prereq: CHE 121 and CHE 123; Coreq: CHE 124

A continuation of CHE 121. Chemical equilibrium, kinetics, acids and bases, ionic equilibrium, electrochemistry, thermodynamics. Four hours lecture.

CHE 123 General Chemistry I Lab	No credit
Fall	Prereq: Two years of high school mathematics, one year of high school chemistry, or consent of instructor; Coreq: CHE 121

A lab course intended to supplement CHE 121 and provide an introduction to fundamental laboratory techniques, such as weighing, filtering, and titrating, as well as the accurate recording and analysis of scientific data. Three hours laboratory.

CHE 124 General Chemistry II Lab	No credit
Spring	Prereq: CHE 121 and CHE 123; Coreq: CHE 122

A lab course intended to supplement CHE 122. (A continuation of CHE 123.) Students will apply skills learned in CHE 123 to more complex experiments, as well as be introduced to more advanced techniques. Three hours laboratory.

CHE 221 Organic Chemistry I	3 credit hours
Fall	Prereq: CHE 122; Coreq: CHE 223

An introduction to the study of carbon and its compounds through an examination of the hydrocarbon, halide, alcohol, and carbonyl functional groups. Emphasis is placed on establishing relationships among structure, physical properties, and chemical activity. The mechanisms of substitution and elimination reactions are studied in detail. Three hours lecture.

CHE 222 Organic Chemistry II		3 credit hours
Spring		Prereq: CHE 221; Coreq: CHE 224

A continuation of CHE 221. Additional functional groups and mechanisms are studied as well as the influence of functional groups on one another in multifunctional compounds. NMR and infrared spectroscopic techniques are used as tools to probe both structure and reactivity. Mass spectroscopy is applied to problems dealing with the structure. Three hours lecture.

CHE 223 Organic Chemistry Laboratory I		1 credit hour
Fall		Coreq: CHE 221

Macroscale and microscale laboratory techniques, preparation and characteristic reactions of organic compounds. Three hours laboratory.

CHE 224 Organic Chemistry Laboratory II		2 credit hours
Spring		Prereq: CHE 223; Coreq: CHE 222

Preparation and characteristic reactions of additional functional groups and qualitative analysis. Experience is also gained in spectroscopic techniques, molecular modeling, the retrieval of data from the chemical literature and formal report preparations. Four hours laboratory.

CHE 227 Analytical Chemistry		4 credit hours
Fall		Prereq: CHE 122 or consent of instructor

An introduction to the principles and methods of chemical analysis, including method development, elementary statistics, separation methods, gravimetric and volumetric analysis, and instrumental methods. The laboratory emphasizes the analysis of samples using analytical techniques. Three hours lecture, three hours laboratory.

CHE 300 Topics in Chemistry		3 credit hours

A topic of current interest in chemistry will be taught. Topics will vary depending on faculty interest. Course will be offered upon request of a faculty member and with approval of the Vice President of Academic Affairs.

CHE 314 Techniques in Forensic Science		3 credit hours
Spring, odd academic years		Prereq: CHE 122 and BIO 140, or instructor permission

The laboratory techniques used in Forensic Science are frequently portrayed in film and television. However, rarely are these practices accurately portrayed. This course will focus on the chemistry and biology laboratory techniques, instrumentation, practices, and applications commonly used in the field of forensic science. The course will consist of a 2 credit hour lecture period and a 1 credit hour lab period to touch on both the theory and practical application of the topics discussed. Same as BIO 314.

CHE 322 Spectroscopic Methods of Analysis		2 credit hours
Spring, odd academic years		Prereq: CHE 222 and CHE 224

An advanced course in spectral interpretation of organic molecules. Techniques investigated include nuclear magnetic resonance spectra, mass spectra, infrared absorption, and ultraviolet absorption spectra.

CHE 334 Biochemistry		3 credit hours
Spring		Prereq: BIO 140, CHE 221 and CHE 223

An introduction to the chemistry of biomolecules, metabolism, and biosynthesis. Three hours lecture. Note: This course may count toward either a Chemistry major or a Biology major, but not both. Same as BIO 334.

CHE 341 Physical Chemistry I		3 credit hours
Fall		Prereq: CHE 122, MAT 135, PHY 201 or PHY 211, and PHY 203 Coreq: CHE 343

Chemical thermodynamics. A study of the laws of thermodynamics with particular emphasis on applications to thermochemistry, solutions, chemical equilibrium, phase equilibria, chemical kinetics, and electrochemistry. Three hours lecture. Same as PHY 341. *Corequisite: CHE 343. Highly recommended MAT 142.*

CHE 342 Quantum Chemistry and Spectroscopy		3 credit hours
Spring, odd academic years		Prereq: CHE 122, MAT 135, PHY 201 or PHY 211, and PHY 203

Elementary quantum mechanics, group theory, and atomic and molecular structure and spectroscopy. Three hours lecture. Same as PHY 342.

CHE 343 Physical Chemistry Lab I		2 credit hours
Fall		Coreq: CHE 341

An introduction to the types of laboratory instrumentation and methods used every day by professional physical and inorganic chemists in research and industry. Substantial emphasis is placed on individual and team responsibility, careful and thoughtful planning, experimentation, data interpretation, and effective communication of results. Experiments will be closely associated with thermodynamics, chemical equilibrium, and include some spectroscopy of primarily inorganic compounds. Four hours laboratory (including pre-lab lecture). Same as PHY 343.

CHE 344 Quantum Chemistry and Spectroscopy Lab		1 credit hour
Spring		Prereq: CHE 342 (or concurrently)

An introduction to the types of laboratory instrumentation and methods used every day by professional physical and inorganic chemists in research and industry. Substantial emphasis is placed on individual and team responsibility, careful and thoughtful planning, experimentation, data interpretation, and effective communication of results. Experiments will be closely associated with kinetics, electrochemistry, computational chemistry, and a continuation of spectroscopy. Three hours laboratory. Same as PHY 344.

CHE 357 Radiation and Health		3 credit hours
Fall, even academic years		Prereq: CHE 121 & CHE 122 or consent of instructor

This course will provide students with an introduction to the principles of radioactivity and its applications in medical diagnosis. A study of basic physics and chemistry as it applies to radiation and the human body (radiobiology) is followed by an overview of major topics in the field of medical physics: x-rays and their uses in medical imaging, physics of nuclear medicine imaging, ultrasound imaging, magnetic resonance imaging, and radiation therapy for cancer. The course will also include a summary of basic principles for measuring radiation exposure, and different methods of monitoring and protecting against chronic exposure to radiation. Same as PHY 357.

CHE 375 Undergraduate Research in Biology, Chemistry or Physics	1-3 credit hours
	Prereq: instructor permission

To receive academic credit for an undergraduate research experience students must complete a project proposal endorsed by a sponsoring science faculty member. The application will contain an overview of the project, specific project goals, deadlines for the completion of the project, and specific project outcomes that will be evaluated and used to determine the final grade. All projects must meet the following criteria: a) spending an average of 3 hours per week per credit hour (i.e. 6 hours/week during the semester for 2 credits) working on the project; b) writing a scientific paper summarizing the results of the study; c) preparing an electronic poster of the project results; d) maintaining a lab notebook, and e) presenting the results of the project to an audience (at least once per year). The project must be approved by the Chair (or designee) of the sponsoring department.

CHE 390 Professional Development Planning	1 credit hour
Fall and spring	

The primary objective of this course is to prepare students for the Professional Development Experience and chosen careers. Students will participate in professional development workshops and write a proposal for their senior year experience.

CHE 392 Techniques in Biotechnology and Biochemistry	3 credit hours
Spring, odd academic years	Prereq: BIO 140, CHE 121, & CHE 122

An advanced investigation of genetic engineering and recombinant DNA technology, this course will investigate the theory and principles behind the new biological revolution in molecular biotechnology. Medical and industrial applications as well as ethical concerns will be discussed. Lab work will involve learning recombinant DNA techniques that are the cornerstone of molecular biology. Two hours lecture, three hours laboratory. Note: This course may count toward either a Chemistry major or a Biology major, but not both. Note: this course may count toward either a Chemistry major or a Biology major but not both. Same as BIO 392.

CHE 434 Advanced Inorganic Chemistry	3 credit hours
Fall, even academic years	Prereq: CHE 222 or consent of instructor

Theoretical principles of inorganic chemistry. Topics include atomic and molecular structure, group theory, chemical bonding, coordination compounds, and the periodic classification of the elements. Three hours lecture.

CHE 448 Instrumental Analysis	3 credit hours
Spring, even academic years	Prereq: CHE 227, or consent of instructor

Introduction to the theory and practice of modern analytical instrumentation. Chromatography, quantitative spectrometry, electroanalytical, and other instrumental techniques are discussed. Representative samples are analyzed using instrumental methods. Two hours lecture, four hours laboratory.

CHE 472 Chemistry Seminar	2 credit hours
Fall	Prereq: Junior standing or consent of instructor

Presentation of current and historical topics in chemistry. This course emphasizes practice and presentation of oral and written reports.

CHE 482 Chemistry Practicum	1-2 credit hours
	Prereq: instructor permission

A supervised, pre-approved experience which allows a student to pursue specific learning goals and/or be involved in a field experience during the regular academic semester.

CHE 490 Independent Study	1-2 credit hours
	Prereq: consent of department

Independent investigation of some problem in one of the fields of chemistry by students who have completed the minimum requirements for a major in chemistry.

CHE 499 Senior Competency Practicum	No credit

An examination taken by senior majors to assess their knowledge of the field of chemistry and their ability to apply this knowledge to solve practical problems. Normally given during the fall term of the student's senior year. Consists of an oral examination and/or a written Major Field Test from the Educational Testing Service. Passing grade D- or higher.

PDP 301 Health Professions Career Preparation	1 credit hour
Fall	

This course will help students to prepare for careers in the health professions and for the application process involved in graduate health program admissions. Topics covered will include, but are not limited to: 1) understanding and navigating the application/admissions process 2) developing competencies as a pre-health student 3) assessing professional programs and finding your fit 4) preparing for entrance exams 5) writing personal statements 6) preparing for interviews 7) balancing work-school-life & preventing burnout 8) funding your education. The course may also include guest speakers and/or field trips and will provide a space for discussing special topics of student interest. Pass/Fail.

SNR/SNT 489 Professional Development Experience –BIO, CHE & PHY	3-15 credit hours
Fall, spring, or summer	Prereq: Senior standing or consent of the department

This course provides a practical Professional Development Experience related to the field of biology or chemistry. Prerequisite: BIO 390 or CHE 390, and approved Professional Development Experience Proposal (signed by the department chair) and Internship Report I. (All prerequisite materials must be submitted to the supervising faculty member prior to the first day of the semester.)

Physics Course Descriptions

PHY 201 General Physics I - Algebra	5 credit hours
Fall	Scientific Thinking exploratory Prereq: MAT 131 or MAT 135 or permission of the instructor (successful completion of a math pretest); Co-req: PHY 203

An introductory course of a two-semester sequence of algebra-based physics that covers the following topics: linear motion, vector methods, Newton's laws of motion, forces, gravitation, circular motion, work and energy, momentum, rotational motion, equilibrium, fluids, vibrations, waves, periodic motion and sound, fluids and solids. The course is appropriate for biology and chemistry majors and pre-professional students (pre-med, pre-dental, pre-optometry, exercise science, etc.). Four hours lecture, two hours laboratory.

PHY 202 General Physics II – Algebra	5 credit hours
Spring	Prereq: PHY 201 and PHY 203; Co-req: PHY 204

A second course of a two-semester sequence of algebra-based physics that covers the following topics: electrostatics, electricity and magnetism, DC and AC circuits, light and geometric optics, atomic and nuclear structure, heat and thermodynamics. Four hours lecture, two hours laboratory. The course is appropriate for biology majors and pre-professional students (pre-med, pre-dental, pre-optometry, etc.).

PHY 203 General Physics I Lab		No credit
Fall		Co-req: PHY 201 or PHY 211

Lab component of General Physics I. A laboratory-based course that introduces measurement, data acquisition and analytical techniques in physics.

PHY 204 General Physics II Lab		No credit
Spring		Co-req: PHY 202 or PHY 212

Lab component of General Physics II. A laboratory-based courses that consolidates the theoretical principles in the course using experimental physics techniques.

PHY 211 General Physics I – Calculus		5 credit hours
Fall, even academic years	Scientific Thinking exploratory	<i>Prereq: MAT 135; Co-req: PHY 203</i>

An introductory course of a two-semester sequence of calculus-based physics that introduces the theories, concepts, and techniques of mechanics (kinematics, work and energy, dynamics, rotation, gravitation, and waves) and the application of mechanics to heat flow, called thermodynamics. The course is appropriate for chemistry, physics, mathematics and engineering majors. Four hours lecture, two hours laboratory.

PHY 212 General Physics II – Calculus		5 credit hours
Spring, even academic years		Prereq: PHY 211 and PHY 203; Co-req: PHY 204

A second course of a two-semester sequence of calculus-based physics. Topics of study include: electricity and magnetism, DC and AC circuits, and geometrical and physical optics, light, and atomic physics. Four hours lecture, two hours laboratory. The course is appropriate for chemistry, physics, mathematics and engineering majors. Four hours lecture, two hours laboratory.

PHY 240 Modern Physics		3 credit hours
On demand		Prereq: PHY 202

An examination of the breakdown of classical physics and the rise of quantum theory. Topics include: special and general relativity, the kinetic theory of gases, an introduction to quantum mechanics and its application to atomic structure, solid state physics, and nuclear physics. The course includes laboratory study of relativistic beta spectroscopy, black body radiation, and the photoelectric effect.

PHY 300 Topics in Physics		3 credit hours

A topic of current interest in physics will be taught. Topics will vary depending on faculty and student interest. The course will be offered upon the request of a faculty member and with approval of the Vice President of Academic Affairs.

PHY 341 Physical Chemistry I		3 credit hours
Fall		Prereq: CHE 122, MAT 135, PHY 201 or PHY 211, and PHY 203 Coreq: CHE 343

Chemical thermodynamics. A study of the laws of thermodynamics with particular emphasis on applications to thermochemistry, solutions, chemical equilibrium, phase equilibria, chemical kinetics, and electrochemistry. Three hours lecture. Same as CHE 341. *Corequisite: CHE 343. Highly recommended MAT 142.*

PHY 342 Quantum Chemistry and Spectroscopy		3 credit hours
Spring, odd academic years		Prereq: CHE 122, MAT 135, PHY 201 or PHY 211, and PHY 203

Elementary quantum mechanics, group theory, and atomic and molecular structure and spectroscopy. Three hours lecture. Same as CHE 342.

PHY 343 Physical Chemistry Lab I		2 credit hours
Fall		Coreq: PHY 341

An introduction to the types of laboratory instrumentation and methods used every day by professional physical and inorganic chemists in research and industry. Substantial emphasis is placed on individual and team responsibility, careful and thoughtful planning, experimentation, data interpretation, and effective communication of results. Experiments will be closely associated with thermodynamics, chemical equilibrium, and include some spectroscopy of primarily inorganic compounds. Four hours laboratory (including pre-lab lecture). Same as CHE 343.

PHY 344 Quantum Chemistry and Spectroscopy Lab		1 credit hour
Spring		Prereq: PHY 342 (or concurrently)

An introduction to the types of laboratory instrumentation and methods used every day by professional physical and inorganic chemists in research and industry. Substantial emphasis is placed on individual and team responsibility, careful and thoughtful planning, experimentation, data interpretation, and effective communication of results. Experiments will be closely associated with kinetics, electrochemistry, computational chemistry, and a continuation of spectroscopy. Three hours laboratory. Same as CHE 344.

PHY 355 Ultrasonography		3 credit hours
Spring, odd academic years, rotating with PHY 365		Prereq: BIO 210 & 215 or ANAT 210 & 220 or BIO 360 or consent of instructor

Ultrasound is integrated in the health professions and medical education curriculum extensively because of its non-invasive nature and diagnostic utility. The course is divided into four sections: introductory ultrasonography, musculoskeletal, cardiovascular, and abdominal ultrasonography. The course provides hands-on training for proper utilization and appropriate operation of ultrasound equipment to assess various regions of the body, as well as a review of Focused Assessment with Sonography in Trauma (FAST) assessment. Same as BIO 355.

PHY 357 Radiation and Health		3 credit hours
Fall, even academic years		Prereq: CHE 121 & CHE 122 or consent of instructor

This course will provide students with an introduction to the principles of radioactivity and its applications in medical diagnosis. A study of basic physics and chemistry as it applies to radiation and the human body (radiobiology) is followed by an overview of major topics in the field of medical physics: x-rays and their uses in medical imaging, physics of nuclear medicine imaging, ultrasound imaging, magnetic resonance imaging, and radiation therapy for cancer. The course will also include a summary of basic principles for measuring radiation exposure, and different methods of monitoring and protecting against chronic exposure to radiation. Same as CHE 357.

PHY 365 Biomedical Optics		3 credit hours
Spring, odd academic years, rotating with PHY 355		

This course will be broadly divided into three categories: geometrical, physical, and visual optics that are pertinent to human-eye-related biomedical and clinical applications. It will begin with the discussion of foundations of geometrical optics describing the behavior of light as rays during reflection, refraction, and dispersion, as well as analyzing optical images, designs and systems and the associated aberrations. The physical-optics aspect of this course introduces the wave model of light propagation and applies it in describing various phenomena like refraction and reflection, dispersion, interference, polarization, and diffraction. This will be followed by a concise deliberation of a few topics related to the quantum nature of light and quantum optics. The final part of the course will address the optics of human eye emphasizing the propagation and interactions of light in biological tissues and physiology of a visual system.

PHY 375 Undergraduate Research in Biology, Chemistry or Physics		1-3 credit hours
		Prereq: instructor permission

To receive academic credit for an undergraduate research experience students must complete a project proposal endorsed by a sponsoring science faculty member. The application will contain an overview of the project, specific project goals, deadlines for the completion of the project, and specific project outcomes that will be evaluated and used to determine the final grade. All projects must meet the following criteria: a) spending an average of 3 hours per week per credit hour (i.e. 6 hours/week during the semester for 2 credits) working on the project; b) writing a scientific paper summarizing the results of the study; c) preparing an electronic poster of the project results; d) maintaining a lab notebook, and e) presenting the results of the project to an audience (at least once per year). The project must be approved by the Chair (or designee) of the sponsoring department.

PHY 482 Physics Practicum		1-2 credit hours
		Prereq: departmental consent

Supervised, pre-approved academic credit awarded for qualified work in an industrial, government, or academic research laboratory.

PHY 490 Independent Study		1-2 credit hours
		Prereq: departmental consent

Individualized reading or research project in an area not covered in regular courses.

AST 110 Astronomy		4 credit hours
Fall, odd academic years	Human Behavior & Scientific Thinking exploratories	

This introductory course provides an overview of our understanding of the universe at an elementary level including the Big Bang, the formation of elements, the solar system, planets and the search for life beyond Earth, stars, galaxies, black holes, dark matter, dark energy and the expanding universe. Students will also explore how humans have historically observed, interpreted and responded to the sky examining cultural perspectives, myths, and common misconceptions to understand how scientific knowledge spreads and is received. No prior math experience is required as the course begins with basic mathematical thinking needed for some topics and students will visit local astronomical sites and observatories to connect scientific concepts with observation and historical context.

ESC 118 Earth Science		4 credit hours
Fall and Spring	Scientific Thinking exploratory	

An introduction to the principles of physical geology including plate tectonics, geological time, origins of rock types, erosion, and glaciation. Students will be expected to attend one half-day field trip to an off-campus site. The instructor will seek to offer students a choice of multiple Saturday dates during the semester. Three hours lecture, two hours lab.