The College of Science faculty and students pursue both curiosity-driven, fundamental research to better understand the broader world and use-inspired research to tackle some of the grand challenges of science, engineering, business and education.

128 Kidder Hall
Oregon State University
Corvallis, OR 97331-4608
Phone: 541-737-4811
Email: science@oregonstate.edu
Website: science.oregonstate.edu (http://www.science.oregonstate.edu/)
Social media: @OSUScience (https://twitter.com/OSUScience/)

Student Services
Science Success Center
109 Kidder Hall
Oregon State University
Corvallis, OR 97331-4608
Phone: 541-737-3854
Website: https://www.science.oregonstate.edu/advising-and-student-services (https://www.science.oregonstate.edu/advising-and-student-services/)

Heather J. Arbuckle, Head
Advisor, 541-737-4786, heather.arbuckle@oregonstate.edu
Transfer Advisor and Recruiter, science.advising@oregonstate.edu

Jen Olarra, Student Success Advisor, 541-737-3854,
jennifer.ollarra@oregonstate.edu (cori.hall@oregonstate.edu)

Gabrielle James, Special
Assistant, 541-737-3279, gabrielle.james@oregonstate.edu

Peer Advisors, 541-737-3854, sciencesuccess@oregonstate.edu

Administration
Roy Haggerty, Dean, roy.haggerty@oregonstate.edu

Henri Jansen, Associate Dean of Academic and Student Affairs, 541-737-9194, henri.jansen@oregonstate.edu

Douglas Keszler, Associate Dean of Research and Graduate Programs, 541-737-6736, doug.keszler@oregonstate.edu

Tamara Cissna, Interim Director of Communications and Marketing, 541-737-4862, tamara.cissna@oregonstate.edu
(debbie.farris@oregonstate.edu)

Chris Larson, Director of Partnerships and Industrial Programs, 541-737-6574, chris.larson@oregonstate.edu

College of Science
We offer internationally recognized undergraduate and graduate programs across the life, physical, mathematical and computational sciences. Specifically, we offer courses of study in biology, biochemistry and biophysics, biochemistry and molecular biology, biohealth sciences, chemistry, microbiology, mathematics, physics, statistics and zoology. We also offer 12 pre-professional programs to prepare students for careers in healthcare or medical professions. Students have opportunities to make original discoveries through research while working alongside world-class scientists.

The College of Science is a nucleus of learning, societal engagement, achievement, and discovery. It offers students an inclusive, welcoming and intellectually stimulating environment to a diverse community.

Research and teaching in the College of Science are enhanced through OSU's outstanding professional schools in engineering, oceanography, agriculture, forestry and pharmacy. Science students can enrich their degrees with courses from these areas.

Majors
The majors of the College of Science are informally divided into these areas:

COMPUTATIONAL AND MATHEMATICAL SCIENCES
- Mathematics and Statistics (graduate only)

Life Sciences
- Biochemistry and Biophysics, Biochemistry and Molecular Biology, BioHealth Sciences, Biology, Microbiology, Molecular and Cellular Biology (graduate only), Zoology

Physical Sciences
- Chemistry and Physics

Double Degrees
Undergraduates with majors in the College of Science can earn a second degree in education, innovation management, international studies, or sustainability. For more information, visit the College of Education, College of Business, International Programs or Department of Forest Ecosystems and Society sections of this catalog.

Pre-Professional Programs
The College of Science offers special programs in health-related fields to help students meet entrance requirements for professional schools in clinical laboratory science, dentistry, medicine, optometry, pharmacy, physical therapy, physician assistant, podiatry and veterinary medicine.

Curricula in Science
Curricula in science lead to the following degrees: Bachelor of Arts (BA), Bachelor of Science (BS), Master of Arts (MA), Master of Science (MS), Professional Science Master's (PSM), and Doctor of Philosophy (Ph.D.). (See the Graduate School for advanced degree requirements.) The College also offers a Master of Arts in Interdisciplinary Studies (MAIS).

Teacher Certification
All professional teacher education is offered through the College of Education. The following majors in the College of Science are good options for students interested in teaching middle school and high school. The College of Science offers an education option in biology (pre-education), chemistry (chemistry education), mathematics (secondary teaching emphasis) and physics (physics education).

Certain mathematics courses (MTH 211, MTH 212, MTH 390) are highly recommended for students who plan to teach elementary or secondary mathematics. See the College of Education section of this catalog for admission to the teacher licensure programs.

Summer Courses for Secondary School Science and Mathematics Teachers
During summer session, the College of Science offers a number of courses designed for high school teachers of science and/or
Scholarships
The College of Science offers many scholarships to incoming and current students (with at least 24 credits at OSU). To learn more or apply, visit our website (https://www.science.oregonstate.edu/scholarships/).

To graduate with a BS degree in the College of Science, undergraduate students must fulfill the following requirements:

- University Baccalaureate Core (48)
- College of Science Requirements (these credits can also fulfill part of the baccalaureate core requirements)
- Mathematical sciences (12)
- Physical, earth, and/or biological sciences (15) to include a two-term sequence (At least one term in biological science and one term in physical or earth science. Must include a two-term sequence in one of these sciences)
- Department requirements (see each department)

Some departments also grant a BA degree that requires a full year of a college-level (200-level or above) foreign language and at least 9 credits of College of Liberal Arts electives in addition to credits required for the baccalaureate core. See the department listings for specific requirements.

A minimum 2.00 GPA is required in College of Science majors and minors; (S/U grading is not allowed in science majors or minors).

The curricula are shown for each major; some substitutions can be made with department and college approval. Unless otherwise indicated, the conditions and credits for research, thesis, reading and conference, and seminar are to be arranged with the instructor involved.

Biochemistry and Biophysics (BB)

BB 100, THE MOLECULES OF LIFE, 2 Credits
A brief introduction to molecular biology for nonspecialists. Subjects vary, but have included biochemical basis of the origin of life, biochemical genetics, biochemical aspects of memory and behavior, mutagenesis, bioenergetics and nutrition, and environmental biochemistry.

Equivalent to: BB 100H

BB 111, INTRODUCTION TO BIOCHEMISTRY AND BIOPHYSICS RESEARCH, 1 Credit
Designed to introduce biochemistry and biophysics students to departmental research opportunities and advisors.

BB 211, PROFESSIONAL DEVELOPMENT II: MOLECULAR, MICROBIAL, BIOHEALTH, 1 Credit
Develop awareness of the elements of professional development, identify strategic areas for growth, and design an exploration plan. Emphasis is placed on being able to analyze career opportunities to determine the best mix of technical and professional skills needed for success as a biological science professional. Graded P/N. CROSSLISTED as BB 211/ BHS 211.

Equivalent to: BHS 211

BB 220, *CANCER: SOCIETY’S MALIGNANT SHADOW, 3 Credits
Explores the social context of our modern understanding of the group of diseases called cancer. Stimulates critical thinking about how trends in prevention, diagnosis, treatment, and care are influenced by the way we view social categories such as race, gender, and socioeconomic class. Demonstrates that access to medical advances is informed by societal beliefs regarding the role of government and other authoritative institutions. (Bacc Core Course)

Attributes: CPDP – Core, Perspective, Difference/Power/Discrimination

BB 314, CELL AND MOLECULAR BIOLOGY, 4 Credits
Fundamental concepts of prokaryotic and eukaryotic cell biology. Emphasizes cell structure and function at the molecular level. Lec/rec.

Prerequisite: (( (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])) and (CH 331 (may be taken concurrently) [C-] or CH 334 (may be taken concurrently) [C-])

Available via Ecampus

BB 314H, CELL AND MOLECULAR BIOLOGY, 4 Credits
Fundamental concepts of prokaryotic and eukaryotic cell biology. Emphasizes cell structure and function at the molecular level. Lec/rec.

Attributes: HNRS – Honors Course Designator

Prerequisite: (( (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])) and (CH 331 (may be taken concurrently) [C-] or CH 334 (may be taken concurrently) [C-])

Equivalent to: BB 314H, BI 314, BI 314H

BB 315, MOLECULAR BIOLOGY LABORATORY, 3 Credits
Laboratory projects exploring the transmission of genetic information from storage to function will introduce students to fundamental molecular biology concepts and techniques, including isolation of DNA, construction of recombinant plasmids, quantification of gene expression in model organisms, polymerase chain reaction, and analysis of protein expression and subcellular localization. Lec/lab.

Prerequisite: BB 314 with C- or better or BB 314H with C- or better

Equivalent to: BI 315
BB 317, *SCIENTIFIC THEORY AND PRACTICE, 3 Credits
Teaches students the practice of biological science. Topics cover scientific theory, communications, ethics and critical evaluation. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (CH 122 with D- or better or CH 202 with D- or better or CH 222 with D- or better or CH 225H with D- or better or CH 226H with D- or better or CH 227H with D- or better or CH 243 with D- or better or CH 244H with D- or better) and (BI 211 [C-] or BI 211H [C-] or BI 212 [C-] or BI 212H [C-]) and (BI 231 [C-] or BI 232 [C-] or BI 233 [C-] or BI 233H [C-]) and (CH 231 with D- or better or CH 232 with D- or better or CH 233 with D- or better or CH 234 with D- or better or CH 235H with D- or better or CH 236 [C-] or CH 236H [C-])
Equivalent to: BI 317

BB 331, *INTRODUCTION TO MOLECULAR BIOLOGY, 3 Credits
Course dealing with the molecular basis of cellular function, with emphasis upon modern developments, and the foundation for practical applications of this knowledge. The course will involve the conceptual background necessary to appreciate the applications of molecular biology. Throughout the course opportunities will be given to discuss public policy issues and questions: What are the moral and practical problems that flow from identification of an individual as being at risk for a late-appearing genetic disorder, such as Huntington’s disease or certain cancers? Does the scientific or public value of knowing the entire DNA sequence of the human genome justify a situation in which individual or small-scale research cannot be supported? What issues arise when the fruits of biological research, mostly publicly funded, are commercialized? Should a novel organism be patented? How can biotechnology be applied to environmental problems? (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Prerequisite: CH 122 with D- or better or CH 202 with D- or better or CH 222 with D- or better or CH 225H with D- or better or ((CH 232 with D- or better or CH 232H with D- or better or CH 236H with D- or better or CH 262H with D- or better or CH 272 with D- or better))
Available via Ecampus

BB 332, *MOLECULAR MEDICINE, 3 Credits
Provides students an understanding of medical advances from a rapidly evolving molecular point of view. Advances in knowledge of the human genome arising from DNA sequencing efforts and major leaps in understanding of the regulating cellular growth and division are presented in an easy-to-understand fashion appropriate for students in all majors. Course discussions and assignments will cover implications of advances in molecular medicine from ethical, economic, technical and societal standpoints. The aim of the course is to present technical material in a way that non-scientists will understand and conversely to summarize ethical, economic, and philosophical considerations in a way that the scientists understand the implications of these technologies. (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Recommended: Any biology course.

BB 345, INTRODUCTION TO BIOLOGICAL SEQUENCE ANALYSIS, 2 Credits
Introduction to computer-based analyses of biomolecular data, particularly nucleic acid and protein sequences, with the Python programming language. Topics include reading and writing of sequence files, subsequences, reverse complement, finding sequence patterns, subroutines, control structures, and parsing complex data files.

BB 350, ELEMENTARY BIOCHEMISTRY, 4 Credits
Service course for students desiring a short introduction to biochemistry. Four lectures weekly.
Prerequisite: CH 331 with D- or better and CH 332 (may be taken concurrently) [D-]
Available via Ecampus

BB 360, INTRODUCTION TO NEUROSCIENCE, 3 Credits
An introduction to the field of neuroscience. Topics include structure of neurons, outline of signaling in the central nervous system, Nernst equation, action potentials, synaptic transmission, chemical signaling in vision, disease and drugs.
Prerequisite: ((CH 231 with D- or better or CH 232 with D- or better or CH 233 with D- or better or CH 234 with D- or better or CH 235H with D- or better or CH 236H with D- or better or CH 237H with D- or better) and (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 231 [C-] or BI 232 [C-] or BI 233 [C-] or BI 233H [C-]) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]))) and (CH 233 [C-] or CH 233H [C-]) and (CH 263 [C-] or CH 263H [C-])
Available via Ecampus

BB 361, NEUROSCIENCE OF SENSORY AND MOTOR SYSTEMS, 3 Credits
Provides advanced knowledge and understanding of the structure and function of the sensory and motor systems and the interactions between them. These systems will be considered in the context of human physiology.
Prerequisite: BB 360 with C- or better

BB 399, SPECIAL TOPICS, 1-16 Credits
Equivalent to: BB 399H
This course is repeatable for 16 credits.

BB 399H, SPECIAL TOPICS, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: BB 399
This course is repeatable for 16 credits.

BB 401, UNDERGRADUATE RESEARCH, 1-16 Credits
Equivalent to: BB 401H
This course is repeatable for 16 credits.

BB 403, THESIS, 1-16 Credits
This course is repeatable for 16 credits.

BB 405, READING AND CONFERENCE, 1-16 Credits
Equivalent to: BB 405H
This course is repeatable for 16 credits.

BB 405H, READING AND CONFERENCE, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: BB 405
This course is repeatable for 16 credits.
BB 407, BIOCHEMISTRY/BIOPHYSICS SEMINAR, 1-16 Credits
Informal seminars presenting information about research problems and careers and research programs on campus in biochemistry or biophysics. Graded P/N.
Equivalent to: BB 407H
This course is repeatable for 99 credits.

BB 407H, BIOCHEMISTRY/BIOPHYSICS SEMINAR, 1-16 Credits
Informal seminars presenting information about research problems and careers and research programs on campus in biochemistry or biophysics. Attributes: HNRS – Honors Course Designator
Equivalent to: BB 407
This course is repeatable for 99 credits.

BB 410, INTERNSHIP, 1-16 Credits
This course is repeatable for 16 credits.

BB 450, GENERAL BIOCHEMISTRY, 4 Credits
Sequence course for students with a limited background in physical chemistry. BB 450/BB 550, three lectures and one recitation. BB 451/BB 551, three lectures.
Prerequisite: CH 332 with D- or better or CH 336 with D- or better
Equivalent to: BB 450H
Available via Ecampus

BB 451, GENERAL BIOCHEMISTRY, 3 Credits
Sequence course for students with a limited background in physical chemistry. BB 450/BB 550, three lectures and one recitation. BB 451/BB 551, three lectures.
Prerequisite: BB 450 with D- or better or BB 450H with D- or better
Equivalent to: BB 451H
Available via Ecampus

BB 453, BIOCHEMISTRY AND MOLECULAR BIOLOGY LABORATORY TECHNIQUES, 4 Credits
Laboratory course for non-majors that introduces students to biochemistry and molecular biology techniques used to investigate the functional relationship between nucleic acid sequence, gene expression, and protein function.
Prerequisite: BB 451 with C- or better

BB 460, ADVANCED CELL BIOLOGY, 3 Credits
History and theory of cell biology; microscopy and other techniques to study cells and organelles; membranes; organelles; protein import; cell signaling; cytoskeleton; cell cycle; stem cells; cell proliferation; cancer biology. Offered every other fall in odd years.
Prerequisite: BB 314 with C- or better or BI 314H with C- or better or BB 314H with C- or better or BB 451 with C- or better or BB 492 with C- or better

BB 481, MACROMOLECULAR STRUCTURE, 3 Credits
An introduction to structural biology, the discipline focused on understanding the structural properties of biological macromolecules—especially proteins and nucleic acids—and relating them to their function. Introduces students to the vocabulary and tools of this discipline, covering both the fundamental physico-chemical principles governing the structure and function of biological macromolecules and a selected set of widely used experimental and theoretical approaches to their characterization. This is done through lectures, and textbook and literature readings. Graduate students receive additional experience in scientific reading, writing and presentation through a literature-based term project.
Prerequisite: BB 450 with D- or better or BB 490 with D- or better
Available via Ecampus

BB 482, BIOPHYSICS, 3 Credits
Examines quantitative properties of biological systems and biological phenomena using concepts derived from mathematics and physics.
Prerequisite: BB 481 with D- or better and CH 440 [D-]

BB 483, ADVANCED BIOCHEMISTRY AND BIOPHYSICS: CAPSTONE, 3 Credits
Covers applications of advanced biophysical techniques, and how these fit within the larger context of biochemistry, biology and society. Explores techniques and their applications to macromolecules as well as the scientific process. Techniques discussed include in vitro, in vivo, and in silico methods, with an emphasis on biomolecular interactions.
Prerequisite: BB 482 with D- or better or BB 582 with D- or better

BB 484, CHROMATIN AND EPIGENETICS, 3 Credits
An in-depth look at “chromatin” (the complex generated by DNA, RNA and complex protein) and how it behaves during gene activation and silencing. Specific examples of long-lasting gene regulation (across cell cycles) will be used to describe the concept of “epigenetic” gene regulation by modification of DNA or proteins. The class will combine more traditional lectures with discussion periods where primary research papers will be analyzed. The target audience is third- and fourth-year students as well as graduate students.
Prerequisite: ((BI 314 with C- or better or BI 314H with C- or better or BB 314 with C- or better or BB 314H with C- or better) and (BI 315 [C-] or BB 315 [C-] or BB 493 [C-] or BB 493H [C-]))

BB 485, APPLIED BIOINFORMATICS, 3 Credits
Fundamental concepts needed to understand the software and methods used in bioinformatics. Includes contemporary techniques such as databases, gene and genome annotations, functional annotations, sequence alignment, motif finding, secondary structure prediction, phylogenetic tree construction, high-throughput sequence data, ChIP-Seq peak identification, transcriptome profiling by RNA-Seq, microRNA discovery and target prediction.
Prerequisite: BB 314 with C- or better or BB 314H with C- or better
BB 486, ADVANCED MOLECULAR GENETICS, 3 Credits
Covers aspects of transmission genetics (Mendel's laws, mapping strategies) informed by the machineries required for genetic information storage, transcription, translation, and protein processing. Analyses of state-of-the-art primary literature and lectures give a perspective on important "model" organisms, including examples from among bacteria, plants, fungi, and animals.
Prerequisite: (BB 314 with C- or better or BB 314H with C- or better) and (BB 492 [C-] or BB 451 [C-])

BB 490, BIOCHEMISTRY 1: STRUCTURE AND FUNCTION, 3 Credits
Examines how the structure and function of biological macromolecules arises from the organic chemistry of their fundamental building blocks. The organic chemistry of biochemistry will be a focus, including the mechanisms by which enzymes catalyze biological reactions.
Prerequisite: (CH 332 with C- or better or CH 336 with C- or better) and (( (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-]) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])))

BB 491, BIOCHEMISTRY 2: METABOLISM, 3 Credits
Sequence professional course to meet the requirements of majors in biochemistry and biophysics. The second course in a series, BB 491/BB 591 covers the mechanisms and regulation of the pathways by which cells break down fuel molecules, conserve some of the released energy in the form of reactive nucleotides, and use this energy to create biological building blocks from simpler metabolites.
Prerequisite: BB 490 with D- or better or BB 590 with D- or better

BB 492, BIOCHEMISTRY 3: GENETIC BIOCHEMISTRY, 3 Credits
Sequence professional course to meet the requirements of majors in biochemistry and biophysics. The third course in the series, BB 492/BB 592 focuses on genetic biochemistry, including the synthesis of nucleotides, DNA synthesis and repair, RNA synthesis and processing, and protein synthesis and modification.
Prerequisite: (BB 490 with D- or better or BB 590 with D- or better) and (BB 491 [D-] or BB 591 [D-])

BB 493, BIOCHEMISTRY LABORATORY MOLECULAR TECHNIQUES 1, 3 Credits
Laboratory course to accompany BB 450, BB 451 or BB 490, BB 491, BB 492. Lec/lab.
Prerequisite: (BB 451 with D- or better or BB 451H with D- or better) or BB 492 with D- or better
Equivalent to: BB 493H

BB 494, BIOCHEMISTRY LABORATORY MOLECULAR TECHNIQUES 2, 3 Credits
Laboratory to accompany BB 450, BB 451 or BB 490, BB 491, BB 492. Lec/lab.
Prerequisite: BB 493 with D- or better or BB 593 with D- or better or BB 315 with D- or better or BB 315 with D- or better
Equivalent to: BB 494H

BB 498, ASBMB CERTIFICATION EXAM, 0 Credits
A comprehensive, standardized test administered by the American Society of Biochemistry and Molecular Biology and used as a direct assessment of the discipline specific knowledge of seniors in the majors administered by the Biochemistry and Biophysics department. A pass will be given to all students who complete the exam. Contact the Biochemistry and Biophysics Program for more information.

BB 499, SPECIAL TOPICS, 0-16 Credits
Topics and credits vary.
This course is repeatable for 16 credits.

BB 501, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

BB 503, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

BB 505, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

BB 507, SEMINAR, 1-2 Credits
Section 1: Descriptions of campus research programs in biochemistry and biophysics, 1 credit fall. Graded P/N. Student presentations of current research literature, 1 credit winter and spring. Should be taken by all entering departmental graduate students. Section 2: Presentation of departmental research seminar, 2 credits any term. PhD candidates in biochemistry and biophysics present a departmental research seminar in the third or fourth year. One registers in the term the seminar is presented. This course is repeatable for 16 credits.

BB 550, GENERAL BIOCHEMISTRY, 4 Credits
Sequence course for students with a limited background in physical chemistry. BB 450/BB 550, three lectures and one recitation. BB 451/BB 551 and BB 452, three lectures.
Recommended: CH 332
Available via Ecampus

BB 551, GENERAL BIOCHEMISTRY, 3 Credits
Sequence course for students with a limited background in physical chemistry. BB 450/BB 550, three lectures and one recitation. BB 451/BB 551 and BB 452, three lectures.
Recommended: BB 550
Available via Ecampus

BB 560, ADVANCED CELL BIOLOGY, 3 Credits
History and theory of cell biology; microscopy and other techniques to study cells and organelles; membranes; organelles; protein import; cell signaling; cytoskeleton; polarity; cell cycle; stem cells; pattern formation; cancer biology
Recommended: BB 314 or BI 314 or BI 314H or BB 492 or BB 451
**BB 581, MACROMOLECULAR STRUCTURE, 3 Credits**

An introduction to structural biology, the discipline focused on understanding the structural properties of biological macromolecules—especially proteins and nucleic acids—and relating them to their function. Introduces students to the vocabulary and tools of this discipline, covering both the fundamental physico-chemical principles governing the structure and function of biological macromolecules and a selected set of widely used experimental and theoretical approaches to their characterization. This is done through lectures, and textbook and literature readings. Graduate students receive additional experience in scientific reading, writing and presentation through a literature-based term project.

**Recommended**: BB 450 or BB 490

*Available via Ecampus*

**BB 582, BIOPHYSICS, 3 Credits**

Examines quantitative properties of biological systems and biological phenomena using concepts derived from mathematics and physics.

**Prerequisite**: BB 581 with D- or better

**BB 583, ADVANCED BIOCHEMISTRY AND BIOPHYSICS: CAPSTONE, 3 Credits**

Covers applications of advanced biophysical techniques, and how these fit within the larger context of biochemistry, biology and society. Explores techniques and their applications to macromolecules as well as the scientific process. Techniques discussed include in vitro, in vivo, and in silico methods, with an emphasis on biomolecular interactions.

**Prerequisite**: BB 582 with C or better

**BB 584, CHROMATIN AND EPIGENETICS, 3 Credits**

An in-depth look at "chromatin" (the complex generated by DNA, RNA and complex protein) and how it behaves during gene activation and silencing. Specific examples of long-lasting gene regulation (across cell cycles) will be used to describe the concept of "epigenetic" gene regulation by modification of DNA or proteins. The class will combine more traditional lectures with discussion periods where primary research papers will be analyzed. The target audience is third- and fourth-year students as well as graduate students.

**Recommended**: (BI 314 or BI 314H) and BI 315

**BB 585, APPLIED BIOINFORMATICS, 3 Credits**

Fundamental concepts needed to understand the software and methods used in bioinformatics. Includes contemporary techniques such as databases, gene and genome annotations, functional annotations, sequence alignment, motif finding, secondary structure prediction, phylogenetic tree construction, high-throughput sequence data, ChIP-Seq peak identification, transcriptome profiling by RNA-Seq, microRNA discovery and target prediction.

**Recommended**: BB 314 or BB 314H

**BB 586, ADVANCED MOLECULAR GENETICS, 3 Credits**

Covers aspects of transmission genetics (Mendel's laws, mapping strategies) informed by the machineries required for genetic information storage, transcription, translation, and protein processing. Analyses of state-of-the-art primary literature and lectures give a perspective on important "model" organisms, including examples from among bacteria, plants, fungi, and animals.

**Recommended**: (BI 314 or BI 314H) and BI 315 and BB 492

**BB 590, BIOCHEMISTRY 1: STRUCTURE AND FUNCTION, 3 Credits**

Examines how the structure and function of biological macromolecules arises from the organic chemistry of their fundamental building blocks. The organic chemistry of biochemistry will be a focus, including the mechanisms by which enzymes catalyze biological reactions.

**BB 591, BIOCHEMISTRY 2: METABOLISM, 3 Credits**

Sequence professional course to meet the requirements of majors in biochemistry and biophysics. The second course in a series, BB 491/BB 591 covers the mechanisms and regulation of the pathways by which cells break down fuel molecules, conserve some of the released energy in the form of reactive nucleotides, and use this energy to create biological building blocks from simpler metabolites.

**Prerequisite**: BB 590 with C or better

**BB 592, BIOCHEMISTRY 3: GENETIC BIOCHEMISTRY, 3 Credits**

Sequence professional course to meet the requirements of majors in biochemistry and biophysics. The third course in the series, BB 492/BB 592 focuses on genetic biochemistry, including the synthesis of nucleotides, DNA synthesis and repair, RNA synthesis and processing, and protein synthesis and modification.

**Prerequisite**: BB 590 with C or better and BB 591 [C]

**BB 593, BIOCHEMISTRY LABORATORY MOLECULAR TECHNIQUES 1, 3 Credits**

Laboratory course to accompany BB 450, BB 451 or BB 490, BB 491, BB 492. Lec/lab.

**Recommended**: (BB 451 or BB 451H) or BB 492

**BB 594, BIOCHEMISTRY LABORATORY MOLECULAR TECHNIQUES 2, 3 Credits**

Laboratory to accompany BB 450, BB 451 or BB 490, BB 491, BB 492. Lec/lab.

**Recommended**: BB 493 or BB 593 or BB 315 or BI 315

**BB 599, SPECIAL TOPICS, 0-16 Credits**

Topics and credits vary.

This course is repeatable for 16 credits.

**BB 601, RESEARCH, 1-16 Credits**

This course is repeatable for 16 credits.

**BB 603, THESIS, 1-16 Credits**

This course is repeatable for 999 credits.
BB 605, READING & CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

BB 607, SEMINAR, 1-2 Credits
Section 1: Descriptions of campus research programs in biochemistry and biophysics, 1 credit fall. Graded P/N. Student presentations of current research literature, 1 credit winter and spring. Should be taken by all entering departmental graduate students. Section 2: Presentation of departmental research seminar, 2 credits any term. PhD candidates in biochemistry and biophysics present a departmental research seminar in the third or fourth year. One registers in the term the seminar is presented.
This course is repeatable for 16 credits.

BB 650, SELECTED TOPICS IN BIOCHEMISTRY AND BIOPHYSICS, 3 Credits
Nonsequence courses designed to acquaint student with current research in biochemistry and biophysics. Courses include enzyme kinetics, cell cycle and cancer, neurochemistry, oxidative stress, cell adhesion and motility. Most courses offered alternate years.
This course is repeatable for 18 credits.

BB 651, SELECTED TOPICS IN BIOCHEMISTRY AND BIOPHYSICS, 3 Credits
Nonsequence courses designed to acquaint student with current research in biochemistry and biophysics. Courses include cell surfaces, enzyme kinetics, metabolism, neurochemistry, trace element metabolism, biological oxidations, and bioenergetics. Most courses offered alternate years.
This course is repeatable for 18 credits.

BB 652, SELECTED TOPICS IN BIOCHEMISTRY AND BIOPHYSICS, 3 Credits
Nonsequence courses designed to acquaint student with current research in biochemistry and biophysics. Courses include enzyme kinetics, metabolism, neurochemistry, trace element metabolism, biological oxidations, and bioenergetics. Most courses offered alternate years.
This course is repeatable for 18 credits.

BB 699, SPECIAL TOPICS, 0-16 Credits
This course is repeatable for 16 credits.

BioHealth Sciences (BHS)

BHS 107, HEALTH PROFESSIONS: DENTAL, 1 Credit
Discussion of matters relating to a dental career. Includes application procedures, the importance of various requirements, admissions, professional school curricula, financing education and related matters. Speakers are included. Graded P/N.

BHS 110, BIOHEALTH SCIENCES ORIENTATION, 1 Credit
Introduction of incoming BioHealth Sciences students to college life with an emphasis on faculties, facilities, services, and curricula in BHS. Exposure to career opportunities for students interested in the BioHealth Sciences. Graded P/N.

BHS 199, SPECIAL TOPICS, 1-16 Credits
Graded P/N.
Equivalent to: GS 199
This course is repeatable for 16 credits.

BHS 211, PROFESSIONAL DEVELOPMENT II: MOLECULAR, MICROBIAL, BIOHEALTH, 1 Credit
Develop awareness of the elements of professional development, identify strategic areas for growth, and design an exploration plan. Emphasis is placed on being able to analyze career opportunities to determine the best mix of technical and professional skills needed for success as a biological science professional. Graded P/N. CROSSTLISTED as BB 211/BHS 211.
Equivalent to: BB 211

BHS 255, ALLIED HEALTH MICROBIOLOGY, 4 Credits
General properties of cellular microbes and viruses, microbial biochemistry and genetics, pathogenesis and disease, immunity, and microbial infections. Lecture and lab emphasis is on medical microbiology, infectious diseases, and public health. Not intended for biological sciences majors. Lec/lab. CROSSTLISTED as BHS 255/MB 255.
Attributes: CPBS – Core, Pers, Biological Science
Equivalent to: MB 255
Available via Ecampus

BHS 316, PRINCIPLES OF IMMUNOLOGY, 3 Credits
Interactions of the innate and adaptive immune responses in the context of infectious diseases, autoimmune diseases, immunodeficiencies and immunotherapies. This course is designed for non-microbiology majors.
Prerequisite: MB 230 with C- or better or ((BI 212 with C- or better or BI 212H with C- or better) and (BI 213 [C-] or BI 213H [C-]) or (BI 204 [C-] and BI 205 [C-]) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]))
Available via Ecampus

BHS 320, HUMAN BACTERIOLOGY, 4 Credits
Prerequisite: (BI 204 with C- or better and BI 205 [C-] and BI 206 [C-]) or ((BI 211 [C-] or BI 211H [C-]) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]))
Equivalent to: MB 320
Available via Ecampus
BHS 323, ^MICROBIAL INFLUENCES ON HUMAN HEALTH, 3 Credits
How microorganisms contribute in beneficial and detrimental ways to human health. Emphasis on microbial contributions to cancer, gut health, chronic infection and autoimmune diseases. This course is part of the Writing Intensive Curriculum for the BioHealth Sciences major. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: MB 302 with D- or better or (BB 314 with D- or better or BB 314H with D- or better) or BB 450 with D- or better
Available via Ecampus

BHS 329, MECHANISMS OF DISEASE: INTRODUCTION TO GENERAL PATHOLOGY, 3 Credits
An introduction to basic principles of disease, focused on structural and functional changes of cells, tissues and organs, and their relationships to clinical disease. The emphasis of the course is at the cellular to organ level, but will cover some on molecular mechanisms as pertinent.
Prerequisite: ((BI 211 with D- or better or BI 211H with D- or better) and (BI 212 [D-] or BI 212H [D-] or (BI 221 [D-] or BI 221H [D-]) and (BI 222 [D-] or BI 222H [D-]))
Available via Ecampus

BHS 340, HUMAN VIROLOGY, 4 Credits
Prerequisite: (BI 204 with C- or better and BI 205 [C-] and BI 206 [C-]) or ((BI 211 [C-] or BI 211H [C-]) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]))
Equivalent to: MB 340
Available via Ecampus

BHS 401, RESEARCH, 1-16 Credits
Equivalent to: GS 401
This course is repeatable for 16 credits.

BHS 403, THESIS, 1-16 Credits
Equivalent to: GS 403
This course is repeatable for 16 credits.

BHS 405, READING AND CONFERENCE, 1-16 Credits
Equivalent to: GS 405
This course is repeatable for 16 credits.

BHS 406, PROJECTS, 1-16 Credits
Graded P/N.
This course is repeatable for 16 credits.

BHS 407, SEMINAR, 1-16 Credits
Graded P/N.
Equivalent to: GS 407
This course is repeatable for 16 credits.

BHS 410, SCIENCE INTERNSHIP, 1-12 Credits
Supervised scientific work experience at selected cooperating institutions, agencies, laboratories, or companies. Graded P/N.
Equivalent to: GS 410
This course is repeatable for 12 credits.

BHS 415, ONE HEALTH IN PRACTICE, 3 Credits
One health is the concept that human, animal and environmental health are all intertwined. Utilizes current one health issues such as disease outbreaks and antimicrobial resistance to encourage students from diverse fields to develop interdisciplinary collaboration and communication skills. CROSSLISTED as BHS 415/VMB 415.
Equivalent to: VMB 415
Recommended: At least third-year standing.

BHS 499, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.

Biology (BI)
BI LD1, GENERAL CREDIT, 1-16 Credits
BI LD2, GENERAL CREDIT, 1-16 Credits
BI 003, UNDERGRADUATE RESEARCH, 0 Credits
Engage in research activities appropriate to the discipline; and through the research experience, acquire skills, techniques, and knowledge relevant to the field of study. In consultation with a faculty mentor, engage in research activity, and make and execute a plan for a project.

BI 101, ^ENVIRONMENTAL BIOLOGY: ECOLOGY, CONSERVATION, GLOBAL CHANGE, 4 Credits
Introduction to ecosystems, including biodiversity, species interactions, human impacts, and conservation biology. Lectures introduce biological themes and research in the context of current issues in science and society. Hands-on laboratories focus on using organisms and technologies to explore biology and develop skills for lifelong learning. No previous science courses are required, intended for non-biological science majors. This course can be taken alone or in any combination with BI 102 or 103. Lec/lab/rec. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science
Available via Ecampus
BI 102, *ANIMAL BIOLOGY: GENES, BEHAVIOR AND EVOLUTION OF LIFE, 4 Credits
Introduction to how genetics shapes life on Earth, including how understandings of DNA and environmental factors are leading to biotechnological advances. Lectures introduce biological themes and research in the context of current issues in science and society. Hands-on laboratories focus on using organisms and technologies to explore biology and develop skills for lifelong learning. No previous science courses are required, intended for non-biological science majors. This course can be taken alone or in any combination with BI 101 and BI 103. Lec/lab/rec. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science
Equivalent to: BI 102H

BI 103, *HUMAN BIOLOGY: ANATOMY, PHYSIOLOGY AND DISEASE, 4 Credits
Introduction to the biology of humans, including aspects of human health and disease. Lectures introduce biological themes and research in the context of current issues in science and society. Hands-on laboratories focus on using organisms and technologies to explore biology and develop skills for lifelong learning. No previous science courses are required, intended for non-biological science majors. This course can be taken alone or in any combination with BI 101 and BI 102. Lec/lab/rec. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science
Equivalent to: BI 103H

BI 109, HEALTH PROFESSIONS: MEDICAL, 1 Credit
Discussion of matters relating to a medical career. Includes application procedures, the importance of various requirements, admissions, professional school curricula, financing education, and related matters. Speakers are included. Graded P/N.

BI 111, INTRODUCTION TO MARINE LIFE IN THE SEA: MARINE HABITATS, 1 Credit
A field-focused learning experience exploring the varied marine life and habitats on the Oregon coast, including rocky shores, sandy beaches, mudflats, bays and estuaries. Students will also be introduced to the breadth of marine science course offerings and research at Oregon State University's Hatfield Marine Science Center located in Newport, Oregon. Graded P/N.
Equivalent to: FW 111

BI 150, INTRODUCTION TO MARINE BIOLOGY, 3 Credits
Survey of marine organisms, the environments they inhabit, and their evolutionary adaptations for thriving in those environments. The course will also highlight current conservation challenges that threaten marine life, such as climate change, overfishing, and pollution.

BI 175, *GENOMES, IDENTITIES AND SOCIETIES, 3 Credits
DNA's roles in shaping our senses of identity, individuality, and societal interconnectivity will be analyzed. New advances in genetic technology will be explored, along with their potential impacts on society. The relationships between genetics and discrimination will be examined with focus on cases from Oregon, America, and the world. (Bacc Core Course)
Attributes: CPDP – Core, Perspective, Difference/Power/Discrimination

BI 197, PROFESSIONAL DEVELOPMENT I: HEALTH PROFESSIONS, 1 Credit
Integrative Biology faculty and other professionals introduce a variety of human health professions including dentistry, medicine, pharmacy and others (veterinary medicine students take BI 198). Emphasizes professional development through exploring relevant social and cognitive concepts, as well as engaging in experiential learning and networking. Departmental and campus student success resources are highlighted. Graded P/N.

BI 198, PROFESSIONAL DEVELOPMENT I: BIOLOGY AND ZOOLOGY, 1 Credit
Integrative Biology faculty and biology professionals introduce life science careers outside of human health professions (human health profession students take BI 197). Emphasizes professional development through exploring relevant social and cognitive concepts, as well as engaging in experiential learning and networking. Departmental and campus student success resources are highlighted. Graded P/N. Available via Ecampus

BI 199, SELECTED TOPICS, 1-16 Credits
Field Ecology.
Equivalent to: BI 199H
This course is repeatable for 16 credits.

BI 199H, SELECTED TOPICS, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: BI 199
This course is repeatable for 16 credits.

BI 204, *INTRODUCTORY BIOLOGY I, 4 Credits
Foundations of biological sciences including scientific inquiry, genetics, evolution, and ecology. Significant emphasis throughout on the application of core concepts to solve human and environmental problems. Laboratory emphasizes skills in critical thinking, scientific writing, and experimental design. Not intended for pre-health profession students. Lec/lab. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science
Available via Ecampus
BI 205, *INTRODUCTORY BIOLOGY II, 4 Credits
Fundamental concepts in molecular and cellular biology, beginning with biomolecules and the origin of life, and ending with genomics. Significant emphasis throughout on applications of biotechnology to solve human problems. Laboratory emphasizes skills in critical thinking, scientific writing, and experimental design. Not intended for pre-health profession students. Lec/lab. (Bacc Core Course) Attributes: CPBS – Core, Pers, Biological Science
Prerequisite: CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-] or CH 271H (may be taken concurrently) [D-] [D-]))
Available via Ecampus

BI 206, *INTRODUCTORY BIOLOGY III, 4 Credits
Basic plant and animal physiology from an evolutionary perspective. Significant emphasis on topics of importance to human society, including human and plant disease. Laboratory emphasizes skills in critical thinking, scientific writing, and experimental design. Not intended for pre-health professional students. Lec/lab. (Bacc Core Course) Attributes: CPBS – Core, Pers, Biological Science
Prerequisite: CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-] or CH 271H (may be taken concurrently) [D-] [D-]))
Available via Ecampus

BI 211, *PRINCIPLES OF BIOLOGY, 4 Credits
Origins of life, energy transformations, plant and animal diversity. Lec/lab. (Bacc Core Course) Attributes: CPBS – Core, Pers, Biological Science
Equivalent to: BI 211H

BI 211H, *PRINCIPLES OF BIOLOGY, 4 Credits
Origins of life, energy transformations, plant and animal physiology. Lec/lab. (Bacc Core Course) Attributes: CPBS – Core, Pers, Biological Science; HNRS – Honors Course Designator
Equivalent to: BI 211

BI 212, *PRINCIPLES OF BIOLOGY, 4 Credits
Cell biology, organ systems, plant and animal physiology. Lec/lab. (Bacc Core Course) Attributes: CPBS – Core, Pers, Biological Science
Prerequisite: (CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better or CH 221 (may be taken concurrently) with D- or better or CH 224H (may be taken concurrently) with D- or better or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-] or CH 271H (may be taken concurrently) [D-][D-]))
Equivalent to: BI 212H

BI 212H, *PRINCIPLES OF BIOLOGY, 4 Credits
Cell biology, organ systems, plant and animal physiology. Lec/lab. (Bacc Core Course) Attributes: CPBS – Core, Pers, Biological Science; HNRS – Honors Course Designator
Prerequisite: (CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better or CH 221 (may be taken concurrently) with D- or better or CH 224H (may be taken concurrently) with D- or better or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-] or CH 271H (may be taken concurrently) [D-][D-]))
Equivalent to: BI 212

BI 213, *PRINCIPLES OF BIOLOGY, 4 Credits
Genetics, evolution, natural selection, and ecology. Lec/lab. (Bacc Core Course) Attributes: CPBS – Core, Pers, Biological Science
Prerequisite: CH 121 with D- or better or CH 201 with D- or better or CH 221 with D- or better or CH 224H with D- or better or ((CH 231 with D- or better or CH 231H with D- or better) and (CH 261 [D-] or CH 261H [D-] or CH 271 [D-]))
Equivalent to: BI 213H

BI 213H, *PRINCIPLES OF BIOLOGY, 4 Credits
Genetics, evolution, natural selection, and ecology. Lec/lab. (Bacc Core Course) Attributes: CPBS – Core, Pers, Biological Science; HNRS – Honors Course Designator
Prerequisite: CH 121 with D- or better or CH 201 with D- or better or CH 221 with D- or better or CH 224H with D- or better or ((CH 231 with D- or better or CH 231H with D- or better) and (CH 261 [D-] or CH 261H [D-] or CH 271 [D-]))
Equivalent to: BI 213
BI 221, *PRINCIPLES OF BIOLOGY: CELLS, 4 Credits
Introduction to fundamental biological concepts and theories about the chemical and molecular basis of life, structure and function, transformation of energy and matter and information flow at a cellular and molecular level. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science
Prerequisite: (CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better) or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-])
Equivalent to: BI 221H

BI 221H, *PRINCIPLES OF BIOLOGY: CELLS, 4 Credits
Introduction to fundamental biological concepts and theories about the chemical and molecular basis of life, structure and function, transformation of energy and matter and information flow at a cellular and molecular level. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science; HNRS – Honors Course Designator
Prerequisite: (CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better) or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-])
Equivalent to: BI 221

BI 222, *PRINCIPLES OF BIOLOGY: ORGANISMS, 4 Credits
Introduction to fundamental biological concepts and theories about plant, and animal physiology, evolution, structure and function, transformation of energy and matter and systems at an organismal level. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science
Prerequisite: (BI 221 with C- or better or BI 221H with C- or better) and ((CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better) or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-]))
Equivalent to: BI 222H

BI 222H, *PRINCIPLES OF BIOLOGY: ORGANISMS, 4 Credits
Introduction to fundamental biological concepts and theories about plant, and animal physiology, evolution, structure and function, transformation of energy and matter and systems at an organismal level. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science; HNRS – Honors Course Designator
Prerequisite: (BI 221 with C- or better or BI 221H with C- or better) and ((CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better) or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-])
Equivalent to: BI 223

BI 223, *PRINCIPLES OF BIOLOGY: POPULATIONS, 4 Credits
Introduction to fundamental biological concepts and theories about diversity, evolution, and ecology, specifically, evolutionary relationship, transformation of energy and matter, information flow and systems at a population level or above. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science
Prerequisite: (BI 221 with C- or better or BI 221H with C- or better) and ((CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better) or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-]))
Equivalent to: BI 223H

BI 223H, *PRINCIPLES OF BIOLOGY: POPULATIONS, 4 Credits
Introduction to fundamental biological concepts and theories about diversity, evolution, and ecology, specifically, evolutionary relationship, transformation of energy and matter, information flow and systems at a population level or above. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science; HNRS – Honors Course Designator
Prerequisite: (BI 221 with C- or better or BI 221H with C- or better) and ((CH 121 (may be taken concurrently) with D- or better or CH 201 (may be taken concurrently) with D- or better) or ((CH 231 (may be taken concurrently) with D- or better or CH 231H (may be taken concurrently) with D- or better) and (CH 261 (may be taken concurrently) [D-] or CH 261H (may be taken concurrently) [D-] or CH 271 (may be taken concurrently) [D-])
Equivalent to: BI 223
BI 231, INTRODUCTION TO HUMAN ANATOMY AND PHYSIOLOGY, 3 Credits
The first of a three-term introductory series. Using a strong gross anatomy focus, course topics address fundamental concepts of biology as they apply to human anatomy and physiology and then focus on understanding the structures, functions, and regulatory mechanisms involved in the human skeleton, muscular and integumentary systems. BI 231 is a required prerequisite to BI 232 and BI 233. The BI 241 Lab is optional but prerequisite for either of the subsequent BI 242 or BI 243 lab courses in the series. Lec.

BI 232, INTRODUCTION TO HUMAN ANATOMY AND PHYSIOLOGY, 3 Credits
The second of a three-term introductory series. Using a strong gross anatomy focus, course topics address the structures, functions and regulatory mechanisms involved in the human nervous, endocrine and reproductive systems. Lec.
Prerequisite: BI 231 (may be taken concurrently) with C- or better

BI 233, INTRODUCTION TO HUMAN ANATOMY AND PHYSIOLOGY, 3 Credits
The third of a three-term introductory series. Using a strong gross anatomy focus, course topics address the structures, functions, and regulatory mechanisms involved in the human cardiovascular, respiratory, urinary and digestive systems. Lec.
Prerequisite: BI 231 (may be taken concurrently) with C- or better

BI 241, INTRODUCTION TO HUMAN ANATOMY AND PHYSIOLOGY LABORATORY, 2 Credits
The first of a three-term introductory series. Using the human cadaver (prosection), course topics address the structures, functions, and regulatory mechanisms involved in the human skeleton, muscular and integumentary systems. Physiology demonstrations illustrate functions of organ systems. Lab/rec.
Prerequisite: BI 231 (may be taken concurrently) with C- or better

BI 242, INTRODUCTION TO HUMAN ANATOMY AND PHYSIOLOGY LABORATORY, 2 Credits
The second of a three-term introductory series. Using the human cadaver (prosection) and dissection of preserved specimens with a strong gross anatomy focus, course topics address the structures, functions and regulatory mechanisms involved in the nervous, endocrine and reproductive systems. Physiology demonstrations illustrate functions of organ systems. Lab/rec.
Prerequisite: BI 231 (may be taken concurrently) with C- or better and BI 232 (may be taken concurrently) [C-] and BI 241 (may be taken concurrently) [C-]

BI 243, INTRODUCTION TO HUMAN ANATOMY AND PHYSIOLOGY LABORATORY, 2 Credits
The third of a three-term introductory series. Using the human cadaver (prosection) and dissection of preserved specimens with a strong gross anatomy focus, course topics address the structures, functions, and regulatory mechanisms involved in the human cardiovascular, respiratory, urinary and digestive systems. Physiology demonstrations illustrate functions of organ systems. Lab/rec.
Prerequisite: BI 231 (may be taken concurrently) with C- or better and BI 233 (may be taken concurrently) [C-] and BI 241 (may be taken concurrently) [C-]

BI 298, PROFESSIONAL DEVELOPMENT FOR BIOLOGISTS II, 1 Credit
Students will develop awareness of the elements of professional development, identify strategic areas for growth, and design an exploration plan. Emphasis is placed on being able to analyze career opportunities to determine the best mix of technical and professional skills needed for success as a biological science professional. Graded P/N.
Equivalent to: BI 298H
Available via Ecampus

BI 299, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.

BI 301, *HUMAN IMPACTS ON ECOSYSTEMS, 3 Credits
Selected human impacts on ecosystems are examined in depth, including air quality, global climate change, management of agricultural and forest resources, and threats to biological diversity. The causes, approaches to investigating, and potential solutions for each issue are discussed from a scientific and social perspective. Adverse effects on ecosystems that result from each environmental problem are examined. (Bacc Core Course)
Attributes: CSGI – Core, Synth, Global Issues
Equivalent to: BI 301H
Recommended: One year of college biology or chemistry

BI 306, *ENVIRONMENTAL ECOLOGY, 3 Credits
Biological, physical, and chemical nature of both natural and human-disturbed ecosystems. Topics include population and conservation ecology, toxins in the food chain and in the environment, forest decline and acid rain, eutrophication of terrestrial and aquatic ecosystems, and ecosystem restoration. Offered alternate years. (Bacc Core Course)
Attributes: CSGI – Core, Synth, Global Issues
Equivalent to: BI 306H
Recommended: One year of college biology and chemistry
**BI 306H, ENVIRONMENTAL ECOLOGY, 3 Credits**
Biological, physical, and chemical nature of both natural and human-disturbed ecosystems. Topics include population and conservation ecology, toxins in the food chain and in the environment, forest decline and acid rain, eutrophication of terrestrial and aquatic ecosystems, and ecosystem restoration. Offered alternate years. (Bacc Core Course)

**Attributes:**
- CSGI – Core, Synth, Global Issues
- HNRS – Honors Course Designator

**Equivalent to:** BI 306

**Recommended:** One year of college biology and chemistry

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**BI 309, TEACHING PRACTICUM, 1-6 Credits**
Introductory experience for students assisting with instruction in Biology or Zoology courses. Admission is by application. See Cordley 3029 for details.

*This course is repeatable for 6 credits.*

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**BI 311, GENETICS, 4 Credits**
Fundamentals of Mendelian, quantitative, population, molecular, and developmental genetics. Lec/rec.

**Prerequisite:** ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])

**Equivalent to:** BI 311H

**Available via Ecampus**

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**BI 311H, GENETICS, 4 Credits**
Fundamentals of Mendelian, quantitative, population, molecular, and developmental genetics. Lec/rec.

**Attributes:**
- HNRS – Honors Course Designator

**Prerequisite:** ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-]) and (ST 351 [D-] or ST 351H [D-])

**Available via Ecampus**

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**BI 315, MOLECULAR BIOLOGY LABORATORY, 3 Credits**
Laboratory projects exploring the transmission of genetic information from storage to function will introduce students to fundamental molecular biology concepts and techniques, including isolation of DNA, construction of recombinant plasmids, quantification of gene expression in model organisms, polymerase chain reaction, and analysis of protein expression and subcellular localization. Lec/lab.

**Prerequisite:** BB 314 with C- or better or BB 314H with C- or better

**Equivalent to:** BB 315

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**BI 319, THEORY, PRACTICE AND DISCOURSE IN THE LIFE SCIENCES, 3 Credits**
The practice of science and the critical evaluation of scientific claims are explored through writings, discussions and presentations. Topics including the scientific method, ethics and the role of science in society are examined along with implications for professionals ranging from health care to environmental biology. Strategies for effectively communicating science with diverse audiences are emphasized. (Writing Intensive Course)

**Attributes:**
- CWIC – Core, Skills, WIC

**Prerequisite:** ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-]) and (ST 351 [D-] or ST 351H [D-])

**Available via Ecampus**

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**BI 331, ADVANCED HUMAN ANATOMY AND PHYSIOLOGY, 3 Credits**
The first of a three-term advanced series. With a strong focus on the physiological underpinnings of disease, course topics address the fundamental concepts of human anatomy and physiology and then focus on understanding the structures, functions, regulatory mechanisms and common pathologies involved in the skeletal, muscular and integumentary systems. Lec.

**Prerequisite:** (((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (CH 123 [C-] or ((CH 233 [C-] or CH 233H [C-]) and (CH 263 [C-] or CH 263H [C-]))) and BI 341 (may be taken concurrently) [C-]

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**BI 332, ADVANCED HUMAN ANATOMY AND PHYSIOLOGY, 3 Credits**
The second of a three-term advanced series. With a strong focus on the physiological underpinnings of disease, course topics address the structures, functions, and regulatory mechanisms involved in the nervous, endocrine and reproductive systems. Lec.

**Prerequisite:** BI 331 with C- or better and BI 342 (may be taken concurrently) [C-]

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**BI 333, ADVANCED HUMAN ANATOMY AND PHYSIOLOGY, 3 Credits**
The third part of a three-term advanced series. With a strong focus on the physiological underpinnings of disease, course topics address the structures, functions, and regulatory mechanisms involved in the cardiovascular, respiratory, urinary and digestive systems. Lec.

**Prerequisite:** BI 332 with C- or better and BI 343 (may be taken concurrently) [C-]
BI 341, ADVANCED HUMAN ANATOMY AND PHYSIOLOGY LABORATORY, 2 Credits
The first of a three-term advanced series. Using the human cadaver (prosection) and physiological data acquisition equipment, course topics address the fundamental concepts of human anatomy and physiology and then focus on understanding the structures, functions, regulatory mechanisms and common pathologies involved in the human skeletal, muscular and integumentary systems. Lab. Corequisites: BI 331

BI 342, ADVANCED HUMAN ANATOMY AND PHYSIOLOGY LABORATORY, 2 Credits
The second of a three-term advanced series. Using the human cadaver (prosection), dissection of preserved specimens, and physiological data acquisition equipment, course topics address the structures, functions, regulatory mechanisms and common pathologies involved in the human nervous, endocrine and reproductive systems. Lab. Corequisites: BI 332

BI 343, ADVANCED HUMAN ANATOMY AND PHYSIOLOGY LABORATORY, 2 Credits
The third of a three-term advanced series. Using the human cadaver (prosection), dissection of preserved specimens, and physiological data acquisition equipment, course topics address the structures, functions, regulatory mechanisms and common pathologies involved in the human cardiovascular, respiratory, urinary and digestive systems. Lab. Corequisites: BI 333

BI 345, *INTRODUCTION TO EVOLUTION, 3 Credits
Elements of evolutionary theory; origin and history of life; evolutionary controversy; origins of species, sex, and humans. (Bacc Core Course) Attributes: CSST – Core, Synthesis, Science/Technology/Society Equivalent to: Z 345 Available via Ecampus

BI 347, *OCEANS IN PERIL, 3 Credits
The interactions of society and the marine environment, emphasizing the ecological, biogeochemical, economic, sociological, and political significance of the oceans. Topics of current critical importance will include marine pollution, protecting marine habitats, conserving marine biodiversity, fisheries and aquaculture, ocean energy, biogeochemical change, global warming, ocean acidification, and sea level rise. (Bacc Core Course) Attributes: CSST – Core, Synthesis, Science/Technology/Society Prerequisite: BI 101 with C- or better or BI 102 with C- or better or BI 211 with C- or better or BI 211H with C- or better or BI 213 with C- or better or BI 213H with C- or better or BI 204 with C- or better or BI 150 with C- or better or BI 221 with C- or better or BI 221H with C- or better
Available via Ecampus

BI 348, *HUMAN ECOLOGY, 3 Credits
The impact of humans on the environment, emphasizing the political, sociological, and ecological consequences of human population growth. Topics of current critical importance will include global warming trends, destruction of the ozone layer, consequences of pollution, habitat destruction, the loss of biodiversity, and conservation biology. (Bacc Core Course) Attributes: CSST – Core, Synthesis, Science/Technology/Society Equivalent to: Z 348 Available via Ecampus

BI 351, MARINE ECOLOGY, 3 Credits
Ecological interactions and principles in different marine habitats. Topics include the organisms (plants, invertebrates, vertebrates) found in major habitats and interactions between organisms. Habitats discussed include coral reefs, rocky shores, kelp forests, near-shore waters, open-ocean waters, and the deep sea. Emphasis is placed on how organism-organism interactions produce varying patterns of distribution, abundance, body size, diversity, stability, and succession. Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-] and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])
Equivalent to: Z 351 Available via Ecampus

BI 353, PACIFIC NORTHWEST COASTAL ECOSYSTEMS, 4 Credits
A field-based introduction to the diversity of ecosystems of the Pacific Northwest coast. Biological and physical processes affecting the distribution, structure, community composition and physical features of these systems are explored through a variety of lectures and field trips. Ecosystem services and human impacts are examined. Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-] and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])

BI 355, SYMBOSES AND THE ENVIRONMENT, 3 Credits
Overview of the diversity of mutualistic symbioses and their roles in the natural environment. Integrative approach, from ecosystem to molecule, to the examination of certain key mutualisms. Lec. Offered alternate years. Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-] and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-]) and (CH 123 [C-] or CH 233 [C-] or CH 233H [C-]) and (CH 263 [C-] or CH 263H [C-])

BI 370, ECOLOGY, 3 Credits
The study of interactions between organisms and their biotic and abiotic environments at the population, community, ecosystem, and biosphere levels of organization. Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-] and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])
Equivalent to: BI 370 Available via Ecampus
BI 370H, ECOLOGY, 3 Credits
The study of interactions between organisms and their biotic and abiotic environments at the population, community, ecosystem, and biosphere levels of organization.
Attributes: HNRS – Honors Course Designator
Prerequisite: (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-]) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])
Equivalent to: BI 370

BI 371, *ECOLOGICAL METHODS, 3 Credits
Experimental design, data collection, analysis and synthesis in ecological studies; local ecosystems emphasized. May have field trip fee. Lec/lab.
(Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: BI 370 with D- or better or BI 370H with D- or better

BI 373, ^FIELD METHODS IN MARINE ECOLOGY, 3 Credits
Exposure to research methods used in field studies of the marine rocky intertidal ecosystem. Research projects and writing exercises provide students with hands-on experience of collecting, analyzing, and presenting marine ecological data. Field trip fee. Lab fee. Lec/lab.
(Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (BI 351 (may be taken concurrently) with D- or better or BI 370 with D- or better or BI 370H with D- or better) and (ST 351 [D-] or ST 351H [D-])
Recommended: ST 352

BI 375, FIELD METHODS IN ECOLOGICAL RESTORATION, 4 Credits
Observation and application of theory and practice in ecological restoration. Using site visits and hands-on research, explores the roles in restoration of fire, local adaptation, disturbance history, natural history, beaver, and soils, including visits to several active and completed restoration projects and overnights in the field. Lab.
Prerequisite: (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-]) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])

BI 399, SPECIAL TOPICS, 0-16 Credits
May be repeated for 16 total credits.
Equivalent to: BI 399H
This course is repeatable for 16 credits.

BI 401, RESEARCH AND SCHOLARSHIP, 1-16 Credits
Equivalent to: BI 401H
This course is repeatable for 16 credits.

BI 401H, RESEARCH AND SCHOLARSHIP, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: BI 401
This course is repeatable for 16 credits.

BI 405, READING AND CONFERENCE, 1-16 Credits
Equivalent to: BI 405H
This course is repeatable for 16 credits.

BI 406, PROJECTS: CURATORIAL ASSISTANT, 1-6 Credits
Students assist with curatorial projects in OSU biological collections. Admission is by application. See Cordley 3029 for details.
This course is repeatable for 6 credits.

BI 407, SEMINAR, 1 Credit
Departmental seminar. Graded P/N.
Equivalent to: BI 407H, BI 407, BOT 407, BOT 407H
This course is repeatable for 16 credits.

BI 407H, SEMINAR, 1 Credit
Departmental seminar. Graded P/N.
Attributes: HNRS – Honors Course Designator
Equivalent to: BI 407
This course is repeatable for 16 credits.

BI 409, ADVANCED TEACHING PRACTICUM, 1-6 Credits
Advanced practicum experience for students assisting in Biology or Zoology courses. Includes advanced training in course content and development of instructional materials. Admission is by application. See Cordley 3029 for details.
This course is repeatable for 6 credits.

BI 410, INTERNSHIP, 1-16 Credits
Graded P/N.
This course is repeatable for 16 credits.
Available via Ecampus

BI 420, ^VIRUSES IN MODERN SOCIETY, 3 Credits
Impact of viruses on modern civilization. Molecular mechanisms of viral infectivity. Approaches to the prevention and cure of viral diseases. Role of viruses in agriculture and industry. Offered alternate years. (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Prerequisite: BI 311 with D- or better or BI 311H with D- or better or BI 314 with D- or better or BI 314H with D- or better

BI 427, PALEOBIOLOGY, 4 Credits
Fossils provide a direct window into the evolution, extinction, and ecology of past life on Earth. A process-based study of the marine and terrestrial fossil record is taken to explore the topics of preservation, macroevolution, extinction of biotas, biomechanics, paleoecology, and climate change. Required laboratory and weekend field trip.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-]) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-]) or GEO 203 [D-]
Equivalent to: Z 427
BI 445, EVOLUTION, 3 Credits
Formal analysis of genetic and ecological mechanisms producing evolutionary change; special topics include speciation, ecological constraints, adaptive radiations, paleontology, biogeography, the origin of life, molecular evolution, and human evolution.
Prerequisite: BI 311 with D- or better or BI 311H with D- or better
Equivalent to: BI 445H

BI 445H, EVOLUTION, 3 Credits
Formal analysis of genetic and ecological mechanisms producing evolutionary change; special topics include speciation, ecological constraints, adaptive radiations, paleontology, biogeography, the origin of life, molecular evolution, and human evolution.
Attributes: HNRS – Honors Course Designator
Prerequisite: BI 311 with D- or better or BI 311H with D- or better
Equivalent to: BI 445

BI 450, ^MARINE BIOLOGY AND ECOLOGY, 15 Credits
A comprehensive lecture and laboratory introduction to the flora and fauna of the marine environment approached from the level of the organism to ecosystem. Ecological patterns and processes characteristic of marine communities will be emphasized. Lec/lab. Taught at Hatfield Marine Science Center, Newport, OR. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (BI 370 with D- or better or BI 370H with D- or better) and (ST 351 [D-] or ST 351H [D-])
Recommended: ST 352
Available via Ecampus

BI 451, FUNCTIONAL ANATOMY OF THE HUMAN MUSCULAR SYSTEM, 4 Credits
In-depth dissection of the orientation, innervation, and functional significance of muscles and muscle groups. Topics include muscle identification, joint anatomy and variation of human form. BI 551 student expectations include vascularization and detailed joint anatomy. The laboratory component will consist of the dissection of the muscular anatomy of a human cadaver. Lab fee. Lec/lab. Taught at Hatfield Marine Science Center, Newport, OR. (Writing Intensive Course)
Prerequisite: (BI 231 with D- or better and BI 241 [D-]) or (BI 331 [D-] and BI 341 [D-]) and (BI 342 [D-]) and ((BI 232 [D-] and BI 242 [D-]) or (BI 332 [D-] and BI 342 [D-]) and ((BI 233 [D-] and BI 243 [D-]) or (BI 333 [D-] and BI 343 [D-]))
Equivalent to: Z 451

BI 454, EVOLUTIONARY GENOMICS, 3 Credits
Examines the evolutionary forces that have produced such varied and complex genomes across the tree of life. The processes by which genomes can be structured, maintained, and remodeled (by nature or by humans) are explored through scientific literature. Special emphasis will be given to recent technological advances in genomics, along with their potential impacts on individuals and society.
Prerequisite: BI 311 with D- or better or BI 311H with D- or better

BI 456, PHYLOGENETICS, 4 Credits
Explores the theory and practice of modern phylogenetic analysis. Emphasis placed on tree reconstruction algorithms, assessment of statistical support, and contemporary issues in phylogenetics. Lab will focus on the use of phylogenetic software and the analysis of molecular data sets. Lec/lab.
Prerequisite: (ST 351 with D- or better or ST 351H with D- or better) and (ST 352 (may be taken concurrently) [D-] or ST 411 (may be taken concurrently) [D-]) and (BI 311 [D-] or BI 311H [D-] or BI 445 [D-] or BI 445H [D-])

BI 481, BIOGEOGRAPHY, 3 Credits
Biogeography is the study of the distribution of biodiversity. We focus on abiotic (geological, climatological) and biotic (ecological, evolutionary) factors that govern diversity across space and through time, emphasizing assembly of communities, global change, and conservation in today’s rapidly changing world. The course format includes lecture, computer-based activities, and discussion. Offered winter term in odd years.
Prerequisite: BI 370 with D- or better or BI 370H with D- or better
Equivalent to: Z 481

BI 483, POPULATION BIOLOGY, 3 Credits
Theoretical and empirical views of the structure and function of populations from across the tree of life, emphasizing the integration of ecological and evolutionary approaches. Lec.
Prerequisite: (MTH 241 with D- or better or MTH 251 with D- or better or MTH 251H with D- or better or MTH 227 with D- or better) and (ST 351 [D-] or ST 351H [D-]) and (ST 352 (may be taken concurrently) [D-] or ST 411 (may be taken concurrently) [D-]) and (BI 311 [D-] or BI 311H [D-] or BI 370 [D-] or BI 370H [D-])
Available via Ecampus

BI 485, MONSTER BIOLOGY, 3 Credits
Scientists seek to explain what exists and why things are. An alternative approach is to ask why things are not. Biological and physical laws are used to critically and rigorously assess why monsters from literature, television and film are not possible in the real world.
Prerequisite: (BI 311 (may be taken concurrently) with D- or better or BI 311H (may be taken concurrently) with D- or better) and (BI 370 (may be taken concurrently) [D-] or BI 370H (may be taken concurrently) [D-])

BI 495, DISEASE ECOLOGY, 3 Credits
An introduction to disease ecology—the study of disease processes in natural populations and communities. The course focuses on (I) the role parasites play in the ecology and evolution of animal populations, including humans; and (II) the relevance of ecological and evolutionary considerations in managing infectious diseases.
Prerequisite: BI 370 with C- or better or BI 370H with C- or better

BI 498, SENIOR BIOLOGY FIELD TEST, 0 Credits
A comprehensive, two-hour exam to assess the biological knowledge of Biology and Zoology seniors. Students must complete the exam in their final undergraduate term or during spring term if graduating during summer when it is not offered. A pass will be given to all students who complete the exam. More details at http://ib.oregonstate.edu/advising/MFT-info.
Available via Ecampus
BI 499, SPECIAL TOPICS, 0-16 Credits
Topics and credits vary.
Equivalent to: BI 499H
This course is repeatable for 16 credits.

BI 499H, SPECIAL TOPICS, 1-16 Credits
Topics and credits vary.
Attributes: HNRS – Honors Course Designator
Equivalent to: BI 499
This course is repeatable for 16 credits.

Chemistry (CH)
CH 101, FOUNDATIONAL SKILLS FOR GENERAL CHEMISTRY, 3 Credits
Provides some extra preparation for students before enrolling in a general chemistry course. Emphasizes the skills required to be successful in general chemistry and the use of those skill in the context of chemistry concepts.
Prerequisite: Math Placement - ALEKS with a score of 046 or MTH 095 (may be taken concurrently) with C- or better or MTH 103 (may be taken concurrently) with C- or better or MTH 105 (may be taken concurrently) with C- or better or MTH 111 (may be taken concurrently) with C- or better or MTH 112 (may be taken concurrently) with C- or better or MTH 241 (may be taken concurrently) with C- or better or MTH 251 (may be taken concurrently) with C- or better or MTH 251H (may be taken concurrently) with C- or better or MTH 252 (may be taken concurrently) with C- or better or MTH 252H (may be taken concurrently) with C- or better or MTH 228 (may be taken concurrently) with C- or better

CH 110, *ROYGBIV: THE CHEMISTRY OF COLORS, 4 Credits
An introduction to the concepts of chemistry and the importance of these concepts in understanding color. Lec/lab.
Attributes: CPPS – Core, Pers, Physical Science
Available via Ecampus

CH 121, GENERAL CHEMISTRY, 5 Credits
A general chemistry sequence for students who have had no previous training in chemistry and for those whose college aptitude test scores indicate the need for a more elementary introduction to chemistry. Entering students are expected to have a working knowledge of high school algebra, logarithms, and scientific notation. Lec/lab/rec. (CH 122, CH 123 are Bacc Core Courses)
Equivalent to: CH 104
Available via Ecampus

CH 122, *GENERAL CHEMISTRY, 5 Credits
A general chemistry sequence intended for majors in fields other than the physical sciences. (CH 122 and CH 123 are Bacc Core courses.) Lec/rec/lab.
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: CH 121 with C- or better or (CH 201 with C- or better or CH 231 with C- or better or CH 231H with C- or better)
Available via Ecampus

CH 123, *GENERAL CHEMISTRY, 5 Credits
A general chemistry sequence intended for majors in fields other than the physical sciences. (CH 122 and CH 123 are Bacc Core courses.) Lec/rec/lab.
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: CH 122 with C- or better or ((CH 232 with C- or better or CH 232H with C- or better) and (CH 262 [C-] or CH 262H [C-] or CH 272 [C-]) or (CH 202 [C-] and CH 205 [C-]))
Available via Ecampus

CH 124, GENERAL CHEMISTRY, 3 Credits
A bridge course, allowing students who have taken one term of General Chemistry (CH 121) to complete the equivalent of one full semester of general chemistry. Entering students are expected to have a working knowledge of high school algebra, logarithms, and scientific notation. Lec/lab.
Prerequisite: CH 121 with D- or better

CH 125, GENERAL CHEMISTRY, 2 Credits
A bridge course, allowing students who also take one term of General Chemistry (CH 123) to complete the equivalent of one full semester of General Chemistry. Entering students are expected to have a working knowledge of high school algebra, logarithms, and scientific notation. Lec/lab. Offered via Ecampus only.
Prerequisite: CH 121 with D- or better and CH 124 [D-]
Recommended: One semester of general chemistry at another institution

CH 130, GENERAL CHEMISTRY OF LIVING SYSTEMS, 4 Credits
Introduction to organic chemistry and the chemistry of biological systems. Organic nomenclature and fundamental reactions, emphasizing topics such as amino acids, proteins, biochemical energy, and nucleic acids (DNA and RNA). Intended as a terminal course in chemistry, not to serve as a prerequisite to higher numbered chemistry courses. Lec/lab. Does not count toward a chemistry minor.
Available via Ecampus

CH 140, GENERAL, ORGANIC, AND BIOLOGICAL CHEMISTRY, 6 Credits
An introduction to general, organic, and biological chemistry. Intended as a terminal course in chemistry, not to serve as a prerequisite to higher numbered chemistry courses. Offered via Ecampus only.
Recommended: Entering students should have a working knowledge of high school algebra, logarithms, and scientific notation
Available via Ecampus

CH 199, SPECIAL TOPICS, 1-3 Credits
This course is repeatable for 3 credits.
CH 201, CHEMISTRY FOR ENGINEERING MAJORS, 3 Credits
A sequence of selected chemistry topics for pre-engineering students. Lec.
Prerequisite: MTH 111 (may be taken concurrently) with D- or better or MTH 112 (may be taken concurrently) with D- or better or MTH 251 (may be taken concurrently) with D- or better or MTH 251H (may be taken concurrently) with D- or better or MTH 252 (may be taken concurrently) with D- or better or MTH 252H (may be taken concurrently) with D- or better or MTH 254 (may be taken concurrently) with D- or better or MTH 254H (may be taken concurrently) with D- or better or Math Placement - ALEKS with a score of 060

CH 202, CHEMISTRY FOR ENGINEERING MAJORS, 3 Credits
A sequence of selected chemistry topics for pre-engineering students. Lec.
Prerequisite: CH 121 with C- or better or CH 201 with C- or better or CH 231 with C- or better or CH 231H with C- or better
Available via Ecampus

CH 205, LABORATORY FOR CH 202, 1 Credit
Three-hour weekly session for the development of laboratory skills in general chemistry for engineers. Lec/lab.
Prerequisite: CH 202 (may be taken concurrently) with D- or better

CH 211, RECITATION FOR CHEMISTRY 201, 1 Credit
80-minute weekly session for the development of problem-solving skills in general chemistry for engineers. Rec.
Corequisites: CH 201

CH 212, RECITATION FOR CHEMISTRY 202, 1 Credit
One-hour weekly session for the development of problem-solving skills in general chemistry for engineers. Rec.
Corequisites: CH 202

CH 220, CAREERS IN CHEMISTRY, 1 Credit
Course for chemistry majors that discusses strategies for success in the study of chemistry and the varied career opportunities available. Topics range from surviving freshman chemistry to choices of advanced classes, study abroad opportunities, internships, getting into and succeeding in graduate school, choices of chemical careers in academia, industry, government, non-governmental organizations, and using chemistry as a foundation for careers in other areas such as law and business. Graded P/N.

CH 231, GENERAL CHEMISTRY, 4 Credits
A general chemistry sequence for students majoring in most sciences, pharmacy, and chemical engineering. CH 231 is a lecture course; CH 261 is the laboratory component. (Bacc Core Course if taken with CH 261)
Attributes: CPPL – Core, Pers, PhySci Attached Lec
Prerequisite: MTH 111 (may be taken concurrently) with C- or better or MTH 112 (may be taken concurrently) with C- or better or MTH 251 (may be taken concurrently) with C- or better or MTH 251H (may be taken concurrently) with C- or better or MTH 252 (may be taken concurrently) with C- or better or MTH 252H (may be taken concurrently) with C- or better or MTH 254 (may be taken concurrently) with C- or better or MTH 254H (may be taken concurrently) with C- or better or Math Placement - ALEKS with a score of 060
Equivalent to: CH 221, CH 231H
Available via Ecampus

CH 231H, GENERAL CHEMISTRY, 4 Credits
A general chemistry sequence for students majoring in most sciences, pharmacy, and chemical engineering. CH 231 is a lecture course; CH 261 is the laboratory component. (Bacc Core Course if taken with CH 261)
Attributes: CPPL – Core, Pers, PhySci Attached Lec; HNRS – Honors Course Designator
Prerequisite: MTH 111 (may be taken concurrently) with C- or better or MTH 112 (may be taken concurrently) with C- or better or MTH 251 (may be taken concurrently) with C- or better or MTH 251H (may be taken concurrently) with C- or better or MTH 252 (may be taken concurrently) with C- or better or MTH 252H (may be taken concurrently) with C- or better or MTH 254 (may be taken concurrently) with C- or better or MTH 254H (may be taken concurrently) with C- or better or Math Placement - ALEKS with a score of 060
Equivalent to: CH 221, CH 231H
Available via Ecampus

CH 232, GENERAL CHEMISTRY, 4 Credits
A general chemistry sequence for students majoring in most sciences, pre-pharmacy, and chemical engineering. CH 232 is a lecture course; CH 262 is the laboratory component. (Bacc Core Course if taken with CH 262)
Attributes: CPPL – Core, Pers, PhySci Attached Lec
Prerequisite: (CH 231 with C- or better or CH 231H with C- or better) or CH 221 with C- or better
Equivalent to: CH 222, CH 225H, CH 232H
Available via Ecampus

CH 232H, GENERAL CHEMISTRY, 4 Credits
A general chemistry sequence for students majoring in most sciences, pre-pharmacy, and chemical engineering. CH 232 is a lecture course; CH 262 is the laboratory component. (Bacc Core Course if taken with CH 262)
Attributes: CPPL – Core, Pers, PhySci Attached Lec; HNRS – Honors Course Designator
Prerequisite: (CH 231 with C- or better or CH 231H with C- or better) or CH 221 with C- or better
Equivalent to: CH 222, CH 225H, CH 232
CH 233, GENERAL CHEMISTRY, 4 Credits
A general chemistry sequence for students majoring in most sciences, pharmacy, and chemical engineering. CH 233 is a lecture course; CH 263 is the laboratory component. (Bacc Core Course if taken with CH 263)
Attributes: CPPL – Core, Pers, PhySci Attached Lec
Prerequisite: (CH 232 with C- or better or CH 232H with C- or better) or CH 222 with C- or better
Equivalent to: CH 223, CH 226H, CH 233H
Available via Ecampus

CH 233H, GENERAL CHEMISTRY, 4 Credits
A general chemistry sequence for students majoring in most sciences, pharmacy, and chemical engineering. CH 233 is a lecture course; CH 263 is the laboratory component. (Bacc Core Course if taken with CH 263)
Attributes: CPPL – Core, Pers, PhySci Attached Lec; HNRS – Honors Course Designator
Prerequisite: (CH 232 with C- or better or CH 232H with C- or better) or CH 222 with C- or better
Equivalent to: CH 223, CH 226H, CH 233H

CH 261, *LABORATORY FOR CHEMISTRY 231, 1 Credit
A general chemistry laboratory sequence for students majoring in most sciences, pharmacy, and chemical engineering. (Bacc Core Course if taken with CH 231)
Attributes: CPPS – Core, Pers, Physical Science
Corequisites: CH 231
Equivalent to: CH 261H, CH 271

CH 261H, *LABORATORY FOR CHEMISTRY 231, 1 Credit
A general chemistry laboratory sequence for students majoring in most sciences, pharmacy, and chemical engineering. (Bacc Core Course if taken with CH 231)
Attributes: CPPS – Core, Pers, Physical Science
Corequisites: CH 231
Equivalent to: CH 261H, CH 271

CH 262, *LABORATORY FOR CHEMISTRY 232, 1 Credit
A general chemistry laboratory sequence for students majoring in most sciences, pharmacy, and chemical engineering. (Bacc Core Course if taken with CH 232)
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: CH 261 with D- or better or CH 261H with D- or better or CH 271 with D- or better or CH 221 with D- or better or CH 224H with D- or better
Corequisites: CH 232
Equivalent to: CH 262H, CH 272

CH 262H, *LABORATORY FOR CHEMISTRY 232, 1 Credit
A general chemistry laboratory sequence for students majoring in most sciences, pharmacy, and chemical engineering. (Bacc Core Course if taken with CH 232)
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: CH 261 with D- or better or CH 261H with D- or better or CH 271 with D- or better or CH 221 with D- or better or CH 224H with D- or better
Corequisites: CH 232
Equivalent to: CH 262H, CH 272

CH 263, *LABORATORY FOR CHEMISTRY 233, 1 Credit
A general chemistry laboratory sequence for students majoring in most sciences, pharmacy, and chemical engineering. (Bacc Core Course if taken with CH 233)
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: CH 262 with D- or better or CH 262H with D- or better or CH 272 with D- or better or CH 222 with D- or better or CH 225H with D- or better
Corequisites: CH 233
Equivalent to: CH 263H, CH 273

CH 263H, *LABORATORY FOR CHEMISTRY 233, 1 Credit
A general chemistry laboratory sequence for students majoring in most sciences, pharmacy, and chemical engineering. (Bacc Core Course if taken with CH 233)
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: CH 262 with D- or better or CH 262H with D- or better or CH 272 with D- or better or CH 222 with D- or better or CH 225H with D- or better
Corequisites: CH 233H
Equivalent to: CH 263H, CH 273

CH 271, *LABORATORY FOR CH 231 FOR CHEMISTRY MAJORS, 1 Credit
A general chemistry laboratory sequence for students majoring in chemistry. (Bacc Core Course if taken with CH 231)
Attributes: CPPS – Core, Pers, Physical Science
Corequisites: CH 231
Equivalent to: CH 271H

CH 272, *LABORATORY FOR CH 232 FOR CHEMISTRY MAJORS, 1 Credit
A general chemistry laboratory sequence for students majoring in chemistry. (Bacc Core Course if taken with CH 232)
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: CH 271 with D- or better or CH 221 with D- or better or CH 224H with D- or better
Corequisites: CH 232
Equivalent to: CH 272H
CH 273, *LABORATORY FOR CH 233 FOR CHEMISTRY MAJORS, 1 Credit
A general chemistry laboratory sequence for students majoring in chemistry. (Bacc Core Course if taken with CH 233)
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: CH 272 with D- or better or CH 222 with D- or better or CH 225H with D- or better
Corequisites: CH 233
Equivalent to: CH 273H

CH 324, QUANTITATIVE ANALYSIS, 4 Credits
A basic course in modern chemical analysis. Self-paced laboratory. CH 130 does not meet the prerequisites for this course.
Prerequisite: CH 123 with D- or better or CH 223 with D- or better or CH 226H with D- or better or ((CH 233 with D- or better or CH 233H with D- or better) and (CH 263 [D-] or CH 263H [D-] or CH 273 [D-]))
Recommended: One year of general chemistry

CH 331, ORGANIC CHEMISTRY, 4 Credits
Service course covering aliphatic and aromatic chemistry. Introduction to nomenclature, mechanism and synthesis. Lec/rec. CH 130 does not meet the prerequisites for this course.
Prerequisite: CH 123 with C- or better or CH 223 with C- or better or CH 226H with C- or better or ((CH 233 with C- or better or CH 233H with C- or better) and (CH 263 [C-] or CH 263H [C-] or CH 273 [C-]))
Recommended: One year of general chemistry
Available via Ecampus

CH 332, ORGANIC CHEMISTRY, 4 Credits
Service course covering aliphatic and aromatic chemistry. Introduction to nomenclature, mechanism and synthesis. Lec/rec.
Prerequisite: CH 331 with C- or better
Recommended: one year of general chemistry.
Available via Ecampus

CH 334, ORGANIC CHEMISTRY, 3 Credits
Professional course for majors in chemistry, biochemistry, chemical engineering and other students who need a year of organic chemistry. In-depth treatment of major classes of organic compounds. Interrelation of mechanistic and synthetic approaches.
Prerequisite: CH 334 with D- or better
Recommended: One year of general chemistry

CH 335, ORGANIC CHEMISTRY, 3 Credits
Professional course for majors in chemistry, biochemistry, chemical engineering and other students who need a year of organic chemistry. In-depth treatment of major classes of organic compounds. Interrelation of mechanistic and synthetic approaches.
Prerequisite: CH 334 with D- or better
Recommended: One year of general chemistry

CH 336, ORGANIC CHEMISTRY, 3 Credits
Professional course for majors in chemistry, biochemistry, chemical engineering and other students who need a year of organic chemistry. In-depth treatment of major classes of organic compounds. Interrelation of mechanistic and synthetic approaches.
Prerequisite: CH 335 with D- or better
Recommended: One year of general chemistry

CH 337, ORGANIC CHEMISTRY LABORATORY, 4 Credits
Laboratory course in organic chemistry for nonmajors, designed to supplement CH 331, CH 332 and CH 334, CH 335, CH 336. Lec/lab.
Prerequisite: (CH 331 with D- or better and CH 332 [D-]) or (CH 334 [D-] and CH 335 [D-] and CH 336 [D-])
Available via Ecampus

CH 361, EXPERIMENTAL CHEMISTRY I, 3 Credits
First term of integrated laboratory program for chemistry majors highlighting techniques in organic, physical, and analytical chemistry. First-hand experience is gained using specialized glassware, scientific equipment and instrumentation plus computers. Essential technical laboratory standards and technical writing are emphasized. Lec/lab.
Prerequisite: (CH 221 with D- or better and CH 222 [D-] and CH 223 [D-]) or (CH 224H [D-] and CH 225H [D-] and CH 226H [D-]) or ((CH 231 [D-] or CH 231H [D-]) and (CH 261 [D-] or CH 261H [D-] or CH 271 [D-] and (CH 232 [D-] or CH 232H [D-]) and (CH 262 [D-] or CH 262H [D-] or CH 272 [D-]) and (CH 233 [D-] or CH 233H [D-]) and (CH 263 [D-] or CH 263H [D-] or CH 273 [D-])) and (MTH 251 (may be taken concurrently) [D-] or MTH 251H (may be taken concurrently) [D-] or PH 201 (may be taken concurrently) [D-] or PH 211 (may be taken concurrently) [D-] or PH 211H (may be taken concurrently) [D-])
Equivalent to: CH 361H

CH 361H, EXPERIMENTAL CHEMISTRY I, 3 Credits
First term of integrated laboratory program for chemistry majors highlighting techniques in organic, physical, and analytical chemistry. First-hand experience is gained using specialized glassware, scientific equipment and instrumentation plus computers. Essential technical laboratory standards and technical writing are emphasized. Lec/lab.
Attributes: HNRS – Honors Course Designator
Prerequisite: ((CH 221 with D- or better and CH 222 [D-] and CH 223 [D-]) or (CH 224H [D-] and CH 225H [D-] and CH 226H [D-]) or ((CH 231 [D-] or CH 231H [D-]) and (CH 261 [D-] or CH 261H [D-] or CH 271 [D-] and (CH 232 [D-] or CH 232H [D-]) and (CH 262 [D-] or CH 262H [D-] or CH 272 [D-]) and (CH 233 [D-] or CH 233H [D-]) and (CH 263 [D-] or CH 263H [D-] or CH 273 [D-])) and (MTH 251 (may be taken concurrently) [D-] or MTH 251H (may be taken concurrently) [D-] or PH 201 (may be taken concurrently) [D-] or PH 211 (may be taken concurrently) [D-] or PH 211H (may be taken concurrently) [D-] and CH 334 (may be taken concurrently) [D-])
Equivalent to: CH 361
CH 362, EXPERIMENTAL CHEMISTRY I, 3 Credits
First-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab.
Prerequisite: (CH 361 with D- or better or CH 361H with D- or better) and CH 335 (may be taken concurrently) [D-]
Equivalent to: CH 362H

CH 362H, EXPERIMENTAL CHEMISTRY I, 3 Credits
First-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab.
Attributes: HNRS – Honors Course Designator
Prerequisite: (CH 361 with D- or better or CH 361H with D- or better) and CH 335 (may be taken concurrently) [D-]
Equivalent to: CH 362

CH 374, TECHNOLOGY, ENERGY, AND RISK, 3 Credits
Decision-making in a technical, democratic society. Discussion of current issues such as acid rain, toxic organic chemicals in the environment, energy resources, etc. Does not meet the prereq for any other chemistry course. Does not meet requirements for chemistry minor. (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Recommended: Completion of Bacc Core in physical science

CH 390, ENVIRONMENTAL CHEMISTRY, 3 Credits
Sources, reactions, transport, effects, and fates of chemical species in water, soil, air, and living environments and the effects of technology thereon.
Prerequisite: CH 331 with D- or better or CH 334 with D- or better
Available via Ecampus

CH 399, SPECIAL TOPICS, 1-16 Credits
Discussion of special topics in chemistry.
This course is repeatable for 99 credits.
Recommended: Completion of Bacc Core in the physical sciences

CH 401, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

CH 403, THESIS, 1-16 Credits
This course is repeatable for 16 credits.

CH 405, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

CH 406, PROJECTS, 1-16 Credits
This course is repeatable for 16 credits.

CH 407, SEMINAR, 1-16 Credits
Equivalent to: CH 407H
This course is repeatable for 16 credits.

CH 407H, SEMINAR, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: CH 407
This course is repeatable for 16 credits.

CH 410, INTERNSHIP, 1-16 Credits
This course is repeatable for 16 credits.

CH 411, INORGANIC CHEMISTRY, 3 Credits
Fundamental principles of inorganic chemistry including atomic structure, bonding models for molecules and solids, symmetry, acid/base chemistry, oxidation-reduction, and metal-ligand complexes.
Recommended: One year of general chemistry and college-level physics
Available via Ecampus

CH 412, INORGANIC CHEMISTRY, 3 Credits
Descriptive chemistry of the elements, focusing on main-group compounds, transition metal complexes, and solid-state chemistry.
Prerequisite: CH 411 with D- or better

CH 418, NUCLEAR CHEMISTRY, 3 Credits
Radioactive decay, nuclear properties, nuclear structure, alpha, beta, and gamma decay, nuclear reactions, fission, interaction of radiation with matter, chemical techniques, radiation safety, and nuclear instrumentation.
Recommended: Concurrent enrollment in (CH 440 or CH 540) or PH 314

CH 421, ANALYTICAL CHEMISTRY, 3 Credits
A professional sequence for majors in chemistry and related disciplines. Chemical equilibrium, analytical electrochemistry, separations, spectroscopy, instrumentation, and treatment of data.
Recommended: One year of general chemistry and one year of college physics. Concurrent enrollment in CH 440 or CH 540

CH 422, ANALYTICAL CHEMISTRY, 3 Credits
A professional sequence for majors in chemistry and related disciplines. Chemical equilibrium, analytical electrochemistry, separations, spectroscopy, basic electronics and instrumentation, and treatment of data.
Recommended: One year of general chemistry and one year of college physics. Concurrent enrollment in CH 441 or CH 541

CH 424, BIOANALYTICAL CHEMISTRY, 3 Credits
Analytical methods employed in the study of biologically important molecules. Separations (chromatography, electrophoresis), spectroscopy, mass spectrometry, biosensors, and immunoassays. Lec/lab. Not offered every year.
Recommended: One year of organic chemistry and one term of organic chemistry laboratory.
CH 435, STRUCTURE DETERMINATION BY SPECTROSCOPIC METHODS, 3 Credits
Use of ultraviolet, infrared, nuclear magnetic resonance, and mass spectra for determination of structures and stereochemistry of complex organic molecules.
Prerequisite: CH 336 with D- or better and (CH 442 [D-] or CH 542 [D-])

CH 440, PHYSICAL CHEMISTRY, 3 Credits
Thermodynamics, electrochemistry, solutions, kinetic theory of gases, chemical kinetics, quantum theory and statistical mechanics, molecular structure and spectroscopy.
Prerequisite: MTH 254 with D- or better or MTH 254H with D- or better
Recommended: One year of general chemistry and one year of college physics
Available via Ecampus

CH 441, PHYSICAL CHEMISTRY, 3 Credits
Thermodynamics, electrochemistry, solutions, kinetic theory of gases, chemical kinetics, quantum theory and statistical mechanics, molecular structure and spectroscopy.
Prerequisite: (CH 440 with C- or better or CHE 311 with C- or better) and (MTH 254 [C-] or MTH 254H [C-])

CH 442, PHYSICAL CHEMISTRY, 3 Credits
Thermodynamics, electrochemistry, solutions, kinetic theory of gases, chemical kinetics, quantum theory and statistical mechanics, molecular structure and spectroscopy.
Prerequisite: (MTH 254 with D- or better or MTH 254H with D- or better) and CH 441 [D-]
Recommended: One year of general chemistry and one year of college physics

CH 450, INTRODUCTORY QUANTUM CHEMISTRY, 3 Credits
Elementary wave mechanics and matrix mechanics of atoms and molecules. Quantum basis of chemical structure. Not offered every year.
Prerequisite: CH 442 with D- or better or CH 542 with D- or better
Recommended: One year college physics

CH 461, EXPERIMENTAL CHEMISTRY II, 3 Credits
Second-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab. (Writing Intensive Course)
Equivalent to: CH 461H

CH 461H, EXPERIMENTAL CHEMISTRY II, 3 Credits
Second-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab. (Writing Intensive Course)
Attributes: HNRS – Honors Course Designator
Equivalent to: CH 461

CH 462, EXPERIMENTAL CHEMISTRY II, 3 Credits
Second-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (CH 362 with D- or better or CH 362H with D- or better) and CH 441 (may be taken concurrently) [D-] and (CH 324 [D-] or CH 461 [D-] or CH 461H [D-])
Equivalent to: CH 462H
Recommended: CH 422

CH 462H, EXPERIMENTAL CHEMISTRY II, 3 Credits
Second-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC; HNRS – Honors Course Designator
Prerequisite: (CH 362 with D- or better or CH 362H with D- or better) and CH 441 (may be taken concurrently) [D-] and (CH 324 [D-] or CH 461 [D-] or CH 461H [D-])
Equivalent to: CH 462
Recommended: CH 422

CH 463, EXPERIMENTAL CHEMISTRY II, 3 Credits
Second-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (CH 362 with D- or better or CH 362H with D- or better) and (CH 324 [D-] or CH 461 [D-]) and CH 442 (may be taken concurrently) [D-]
Equivalent to: CH 463H

CH 463H, EXPERIMENTAL CHEMISTRY II, 3 Credits
Second-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC; HNRS – Honors Course Designator
Prerequisite: (CH 362 with D- or better or CH 362H with D- or better) and (CH 324 [D-] or CH 461 [D-]) and CH 442 (may be taken concurrently) [D-]
Equivalent to: CH 463
CH 464, ^EXPERIMENTAL CHEMISTRY II, 3 Credits
Second-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (CH 362 with D- or better or CH 362H with D- or better) and CH 442 (may be taken concurrently) [D-]
Equivalent to: CH 464H
Recommended: CH 461 or CH 461H or CH 324

CH 464H, ^EXPERIMENTAL CHEMISTRY II, 3 Credits
Second-level integrated laboratory course for majors in chemistry and related disciplines, covering experimental techniques of analytical, inorganic, organic and physical chemistry. Lec/lab. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC; HNRS – Honors Course Designator
Prerequisite: (CH 362 with D- or better or CH 362H with D- or better) and CH 442 (may be taken concurrently) [D-]
Equivalent to: CH 464
Recommended: CH 461 or CH 461H or CH 324

CH 474, INNOVATION TO IMPACT, 2 Credits
Build on skills gained in CH 472/SCI 472 or CH 572/SCI 572 to conduct and refine a first pass product-market gap analysis on one example application of a technology platform for a market segment selected from a defined technology platform. Investigate and determine the opportunity – if any – that a product might have in a chosen market before proposing and executing a research plan. CROSSLISTED as CH 474/SCI 474 and CH 574/SCI 574.
Prerequisite: SCI 472 with C or better or CH 472 with C or better
Equivalent to: SCI 474
Recommended: Undergraduate juniors and seniors in STEM majors

CH 490, COMPUTER PROGRAMMING FOR SCIENTISTS, 3 Credits
Programming, numerical and graphical analysis, problem solving, simulations and use of databases for information handling and retrieval. Applications to problems in chemistry.
Prerequisite: MTH 252 with D- or better or MTH 252H with D- or better

CH 501, RESEARCH, 1-16 Credits
Graded P/N.
This course is repeatable for 16 credits.

CH 503, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

CH 505, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

CH 506, PROJECTS, 1-16 Credits
This course is repeatable for 16 credits.

CH 507, SEMINAR, 1-16 Credits
Student should enroll in the seminar section that meets the specific divisional requirements for credits and grading scheme or that is designated for teaching or mentoring programs. Graded P/N.
This course is repeatable for 16 credits.

CH 510, INTERNSHIP, 1-16 Credits
This course is repeatable for 16 credits.

CH 511, INORGANIC CHEMISTRY, 4 Credits
Fundamental principles of inorganic chemistry including atomic structure, bonding models for molecules and solids, symmetry, acid/base chemistry, oxidation-reduction, metal-ligand complexes, sol-gel chemistry and nanochemistry.
Recommended: CH 442 or CH 542

CH 512, INORGANIC CHEMISTRY, 4 Credits
Descriptive chemistry of the elements, focusing on main-group compounds, transition metal complexes, and solid-state chemistry.
Prerequisite: CH 511 with C or better
CH 513, SOLID STATE CHEMISTRY, 3-4 Credits

Basic principles of chemistry are applied to descriptions of structure-property relationships in inorganic solids. Topics include crystal structure, materials synthesis, chemical bonding, electronic properties, optical properties, and magnetism. Students who register for 4 credits will perform independent study of an advanced topic based on research literature.

This course is repeatable for 4 credits.
Recommended: CH 442 or CH 542

CH 516, RADIOCHEMISTRY, 4 Credits

Selected methods in radiochemical analysis. Actinide chemistry, activation analysis, radionuclide solvent extraction, and microbial reactions with radionuclides. Designed for majors in chemistry, chemical engineering, nuclear engineering, and radiation health physics. Lec/lab. CROSSLISTED as CH 516/NSE 516.

Prerequisite: NE 531 with C or better or (RHP 531 with C or better and RHP 536 [C])
Equivalent to: CHE 516, NE 516, NSE 516, RHP 516
This course is repeatable for 12 credits.

CH 518, NUCLEAR CHEMISTRY, 3 Credits

Radioactive decay, nuclear properties, nuclear structure, alpha, beta, and gamma decay, nuclear reactions, fission, interaction of radiation with matter, chemical techniques, radiation safety, and nuclear instrumentation.

Recommended: Concurrent enrollment in (CH 440 or CH 540) or PH 314

CH 521, ANALYTICAL CHEMISTRY, 3 Credits

A professional sequence for majors in chemistry and related disciplines. Chemical equilibrium, analytical electrochemistry, separations, spectroscopy, instrumentation, and treatment of data.

Recommended: One year of college chemistry and physics. Concurrent enrollment in CH 540

CH 522, ANALYTICAL CHEMISTRY, 3 Credits

A professional sequence for majors in chemistry and related disciplines. Chemical equilibrium, analytical electrochemistry, separations, spectroscopy, basic electronics and instrumentation, and treatment of data.

Recommended: One year of college chemistry and physics. Concurrent enrollment in CH 541

CH 524, BIOANALYTICAL CHEMISTRY, 3 Credits

Analytical methods employed in the study of biologically important molecules. Separations (chromatography, electrophoresis), spectroscopy, mass spectrometry, biosensors, and immunoassays. Lec/lab. Not offered every year.

Equivalent to: VM 524, VMB 524
Recommended: One year of organic chemistry and one term of organic chemistry laboratory.

CH 535, STRUCTURE DETERMINATION BY SPECTROSCOPIC METHODS, 3 Credits

Use of ultraviolet, infrared, nuclear magnetic resonance, and mass spectra for determination of structures and stereochemistry of complex organic molecules.

Recommended: CH 336 and (CH 442 or CH 542)

CH 540, PHYSICAL CHEMISTRY, 3 Credits

Thermodynamics, electrochemistry, solutions, kinetic theory of gases, chemical kinetics, quantum theory and statistical mechanics, molecular structure and spectroscopy.

Recommended: MTH 254 and one year of college chemistry and one year of college physics

CH 541, PHYSICAL CHEMISTRY, 3 Credits

Thermodynamics, electrochemistry, solutions, kinetic theory of gases, chemical kinetics, quantum theory and statistical mechanics, molecular structure and spectroscopy.

Recommended: (CH 440 or CHE 311) AND (MTH 254 or MTH 254H)

CH 542, PHYSICAL CHEMISTRY, 3 Credits

Thermodynamics, electrochemistry, solutions, kinetic theory of gases, chemical kinetics, quantum theory and statistical mechanics, molecular structure and spectroscopy.

Recommended: CH 541

CH 550, INTRODUCTORY QUANTUM CHEMISTRY, 3 Credits

Elementary wave mechanics and matrix mechanics of atoms and molecules. Quantum basis of chemical structure. Not offered every year.

Prerequisite: CH 542 with C or better
Recommended: One year college physics

CH 553, CHEMICAL THERMODYNAMICS, 3 Credits

The laws of chemical thermodynamics applied to analyze properties of gases, gas mixtures, liquid solutions, fluctuations, critical phenomena, and magnetic systems. Not offered every year.

Recommended: CH 542

CH 570, FOUNDATIONS OF INNOVATION, 2 Credits

Learn the basic language and the initial skill set needed to address how scientific ideas and research results become innovations – solutions that address societal and market needs. Acquire the skills to become innovators and to create value for all types of academic, small-company, industrial, governmental, and non-profit research and development organizations. Students work in areas aligned with their scientific interests either individually or in a team. CROSSLISTED as CH 470/SCI 470 and CH 570/SCI 570.

Equivalent to: SCI 570
CH 571, ADVANCED ORGANIC CHEMISTRY, 3 Credits
Principles of synthetic organic chemistry. Particular emphasis will be directed at understanding stereochemical outcomes in carbon-carbon bond-forming reactions (Diels-Alder, aldol, and pericyclic reactions). Other topics will include oxidation/reduction reactions, organometallic chemistry, and enantioselective methodologies.
Recommended: CH 336 or CH 337

CH 572, RESEARCH TO INNOVATION, 2 Credits
Produce a first-pass product-market gap analysis on one example application of a science technology platform in a given market. Define a platform in collaboration with research faculty or from work completed in CH 470/SCI 470 or CH 570/SCI 570. Assess the opportunity – if any – that a product might have for application in a chosen market before planning and conducting scientific research. CROSSLISTED as CH 472/SCI 472 and CH 572/SCI 572.
Prerequisite: SCI 570 (may be taken concurrently) with B or better or CH 570 (may be taken concurrently) with B or better
Recommended: STEM graduate students

CH 574, INNOVATION TO IMPACT, 2 Credits
Build on skills gained in CH 472/SCI 472 or CH 572/SCI 572 to conduct and refine a first pass product-market gap analysis on one example application of a technology platform for a market segment selected from a defined technology platform. Investigate and determine the opportunity – if any – that a product might have in a chosen market before proposing and executing a research plan. CROSSLISTED as CH 474/SCI 474 and CH 574/SCI 574.
Prerequisite: SCI 572 with B or better or CH 572 with B or better
Equivalent to: SCI 574
Recommended: Graduate students in STEM

CH 582, CHEMISTRY AND MATERIALS OF BATTERIES AND SUPER CAPACITORS, 3 Credits
Examines the chemistry and materials currently in use and proposed for future primary and secondary batteries and supercapacitors. After a brief historical review, we will examine in detail the state-of-the-art technologies including lithium-ion, lithium, and sodium-sulfur batteries and electrochemical double-layer capacitors, and future technologies such as metal-air and lithium-sulfur. Class discussions will focus on structure/performance relationships and other issues such as environmental impact, safety and cost. Offered via Ecampus only.
Recommended: Full year of general chemistry, college-level physics and materials science background

CH 584, INSTRUMENTS AND ONLINE INTERACTIONS IN THE SCIENCES, 3 Credits
Examine methods and technologies for and incorporating virtual instruments and online interactions into laboratory courses to support learners in becoming critical thinkers and creative producers of their knowledge and understanding in science.
Recommended: Basic computer literacy and one year of general chemistry, physics or biology
Available via Ecampus

CH 590, COMPUTER PROGRAMMING FOR SCIENTISTS, 3 Credits
Programming, numerical and graphical analysis, problem solving, simulations and use of databases for information handling and retrieval. Applications to problems in chemistry.
Recommended: MTH 252

CH 601, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

CH 603, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

CH 605, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

CH 607, SEMINAR, 1-16 Credits
Student should enroll in the seminar section that meets the specific divisional requirements for credits and grading scheme or that is designated for teaching or mentoring programs.
This course is repeatable for 16 credits.

CH 614, SELECTED TOPICS IN INORGANIC CHEMISTRY, 4 Credits
Nonsequence courses designed to acquaint the advanced graduate student with recent advances in fields such as solid state chemistry, theoretical inorganic chemistry, spectroscopy and magnetism, chemistry of coordination compounds, kinetics and mechanisms of inorganic reactions, acid-base theory and reactions in nonequous solvents, organometallic chemistry, and chemistry of the less familiar elements. Not offered every year.
Equivalent to: CH 514
This course is repeatable for 8 credits.
Recommended: CH 413 or CH 513

CH 615, SELECTED TOPICS IN ORGANIC CHEMISTRY, 4 Credits
Focus is on cutting edge research topics in inorganic materials chemistry, which will evolve from year-to-year to stay up-to-date. Current journal articles, software programs, and lab demonstrations will be utilized. Students will learn both content of a research area, as well as tools used in the practice.
CH 616, CRYSTALLOGRAPHY AND X-RAY DIFFRACTION, 4 Credits
Principles of crystallography and x-ray diffraction as applied to the structural characterization of both single crystals, powders, and thin films.
Equivalent to: CH 516
Recommended: At least one upper-level undergraduate inorganic chemistry course

CH 630, ADVANCED ORGANIC CHEMISTRY, 3 Credits
Molecular orbital bonding theory, orbital symmetry, reaction mechanisms, stereoisomerism, conformational analysis, and advanced methods of synthesis. Not offered every year.
Equivalent to: CH 530
Recommended: CH 336 and (CH 442 or CH 542)

CH 631, ADVANCED ORGANIC CHEMISTRY, 4 Credits
Carbon-carbon bond forming reactions, reaction mechanisms, stereoisomerism, conformational analysis, and advanced methods of synthesis. Not offered every year.
Equivalent to: CH 531
Recommended: CH 630

CH 632, ADVANCED ORGANIC CHEMISTRY, 3 Credits
Molecular orbital bonding theory, orbital symmetry, reaction mechanisms, stereoisomerism, conformational analysis, and advanced methods of synthesis. Not offered every year.
Equivalent to: CH 532
Recommended: CH 336 and (CH 442 or CH 542)

CH 633, HYPOTHESIS, EVIDENCE, AND ARGUMENT IN ORGANIC CHEMISTRY, 2 Credits
Immerses the student in the tools of scientific method as applied to current research topics in the chemical literature. The student will perform an extensive review of a modern topic in organic chemistry, prepare a written summary and analysis of this literature review and make a public oral presentation and discussion.
Prerequisite: CH 632 with C or better
This course is repeatable for 4 credits.

CH 637, SELECTED TOPICS IN ORGANIC CHEMISTRY, 3 Credits
Nonsequence courses designed to acquaint students with advances in organic chemistry, specifically focusing on biosynthesis of natural products and enzyme reaction mechanisms. CH 636, CH 637, CH 638 need not be taken in order.
Equivalent to: CH 537
This course is repeatable for 12 credits.

CH 638, SELECTED TOPICS IN ORGANIC CHEMISTRY, 3 Credits
Nonsequence courses designed to acquaint students with recent advances in organic chemistry and their application to special fields of study. Topics covered vary from term to term and year to year. Topics include: theoretical organic chemistry, recent advances in reaction mechanisms, advanced synthesis, free radical reactions, organic sulfur chemistry, and biosynthesis of natural products. CH 636, CH 637, CH 638 need not be taken in order. Not offered every year.
Equivalent to: CH 538
This course is repeatable for 12 credits.

CH 651, QUANTUM MECHANICS OF ATOMS AND MOLECULES, 3 Credits
Not offered every year.
Equivalent to: CH 551
Recommended: CH 450 or CH 550

CH 652, QUANTUM MECHANICS OF MOLECULAR SPECTROSCOPY, 3 Credits
Not offered every year.
Equivalent to: CH 552
Recommended: CH 651

CH 660, SPECTROCHEMICAL ANALYSIS, 3 Credits
Theoretical concepts and methodology of optical spectrochemical methods of analysis, components of spectrometers, flame and electrothermal atomic spectrophotometry, ICP atomic emission spectrometry, molecular absorption and fluorescence spectrometry.
Equivalent to: CH 560
Recommended: CH 442 or CH 542

CH 661, SEPARATIONS: CHROMATOGRAPHY AND RELATED METHODS, 4 Credits
Theory, instrumentation, and practice of modern separation techniques (gas chromatography, liquid chromatography, electrokinetic separations) and sample preparation methods; handling and interpretation of chromatographic and electrophoretic data.
Equivalent to: CH 561
Recommended: CH 440 or CH 540

CH 666, SELECTED TOPICS IN ORGANIC CHEMISTRY, 3 Credits
Nonsequence courses designed to acquaint students with recent advances in organic chemistry and their application to special fields of study. Topics covered vary from term to term and year to year. Topics include: theoretical organic chemistry, recent advances in reaction mechanisms, advanced synthesis, free radical reactions, organic sulfur chemistry, and biosynthesis of natural products. CH 636, CH 637, CH 638 need not be taken in order. Not offered every year.
Equivalent to: CH 536
This course is repeatable for 12 credits.
CH 662, ANALYTICAL ELECTROCHEMISTRY, 4 Credits
Study of current, voltage and time relationships in electrochemical cells.
Offered alternate years.
Equivalent to: CH 562
Recommended: CH 442

CH 680, SELECTED TOPICS IN PHYSICAL CHEMISTRY, 3 Credits
Nonsequence courses designed to acquaint students with recent advances in physical chemistry. Topics include molecular structure dynamics determination (UV-visible, near-IR light sources, x-ray, electron and neutron diffraction), spectroscopy (ultrafast, nonlinear, multidimensional, multiphoton, magnetic resonance, photoelectron), physical chemistry of condensed phase systems (biomolecules, aqueous solution, novel materials, ionic, molecular and liquid crystals, critical phenomena, mass transport), theoretical chemistry (chemical bonding, scattering theory, group theory, dynamics), electronic structure theory of molecules, structural dynamics of complex systems. Need not be taken in order. Not offered every year.
Prerequisite: CH 550 with B- or better
Equivalent to: CH 580
This course is repeatable for 12 credits.

CH 681, SELECTED TOPICS IN PHYSICAL CHEMISTRY, 2 Credits
Nonsequence courses designed to acquaint students with recent advances in physical chemistry. Topics include molecular structure determination (x-ray, electron and neutron diffraction), spectroscopy (nonlinear and multiphoton, magnetic resonance, photoelectron, Moessbauer effect), physical chemistry of condensed phases (ionic, molecular and liquid crystals, critical phenomena, mass transport), theoretical chemistry (chemical bonding, scattering theory, group theory, dynamics), electronic structure theory of molecules. Need not be taken in order. Not offered every year.
Equivalent to: CH 581
This course is repeatable for 12 credits.

CH 682, SELECTED TOPICS IN PHYSICAL CHEMISTRY, 2 Credits
Nonsequence courses designed to acquaint students with recent advances in physical chemistry. Topics include molecular structure determination (x-ray, electron and neutron diffraction), spectroscopy (nonlinear and multiphoton, magnetic resonance, photoelectron, Moessbauer effect), physical chemistry of condensed phases (ionic, molecular and liquid crystals, critical phenomena, mass transport), theoretical chemistry (chemical bonding, scattering theory, group theory, dynamics), electronic structure theory of molecules. Need not be taken in order. Not offered every year.
Equivalent to: CH 582
This course is repeatable for 12 credits.

CH 683, SELECTED TOPICS IN ANALYTICAL CHEMISTRY, 2 Credits
Nonsequence courses designed to acquaint the advanced graduate student with recent advances in analytical chemistry. Not offered every year.
Equivalent to: CH 583
This course is repeatable for 12 credits.

CH 684, SELECTED TOPICS IN ANALYTICAL CHEMISTRY, 2 Credits
Nonsequence courses designed to acquaint the advanced graduate student with recent advances in analytical chemistry. Not offered every year.
Equivalent to: CH 584
This course is repeatable for 12 credits.

CH 685, SELECTED TOPICS IN ANALYTICAL CHEMISTRY, 2 Credits
Nonsequence courses designed to acquaint the advanced graduate student with recent advances in analytical chemistry. Not offered every year.
Equivalent to: CH 585
This course is repeatable for 12 credits.

CH 686, SELECTED TOPICS IN NUCLEAR AND RADIATION CHEMISTRY, 2 Credits
Nonsequence courses designed to acquaint the advanced graduate student with recent advances in nuclear and radiation chemistry. Not offered every year.
Equivalent to: CH 586
This course is repeatable for 12 credits.

CH 687, SELECTED TOPICS IN NUCLEAR AND RADIATION CHEMISTRY, 2 Credits
Nonsequence courses designed to acquaint the advanced graduate student with recent advances in nuclear and radiation chemistry. Not offered every year.
Equivalent to: CH 587
This course is repeatable for 12 credits.

CH 688, SELECTED TOPICS IN NUCLEAR AND RADIATION CHEMISTRY, 2 Credits
Nonsequence courses designed to acquaint the advanced graduate student with recent advances in nuclear and radiation chemistry. Not offered every year.
Equivalent to: CH 588
This course is repeatable for 12 credits.

CH 692, ENVIRONMENTAL TRANSFORMATION OF ORGANIC COMPOUNDS, 3 Credits
Chemical, photochemical, and biological transformation reactions of organic compounds in the environment. Test methods and predictive models for determining the persistence of organic compounds in the environment. Offered alternate years.
Recommended: CH 336 and CH 440
CH 697, MASS SPECTROMETRY OF ORGANIC COMPOUNDS, 4 Credits
Physical principles of mass spectrometric instrumentation and interpretation of the mass spectra of organic compounds and biomolecules. Not offered every year.
Equivalent to: TOX 637

General Science (GS)
GS 199, SPECIAL STUDIES, 1-16 Credits
Equivalent to: BHS 199
This course is repeatable for 16 credits.

GS 399, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.

GS 401, RESEARCH, 1-16 Credits
Equivalent to: BHS 401
This course is repeatable for 16 credits.

GS 403, THESIS, 1-16 Credits
Equivalent to: BHS 403
This course is repeatable for 16 credits.

GS 405, READING AND CONFERENCE, 1-16 Credits
Equivalent to: BHS 405
This course is repeatable for 16 credits.

GS 407, SEMINAR, 1-16 Credits
One-credit sections. Graded P/N.
Equivalent to: BHS 407
This course is repeatable for 16 credits.

GS 410, SCIENCE INTERNSHIP, 1-12 Credits
Supervised scientific work experience at selected cooperating institutions, agencies, laboratories, or companies. Graded P/N.
Equivalent to: BHS 410
This course is repeatable for 12 credits.

Integrative Biology (IB)
IB 501, RESEARCH, 1-16 Credits
Graduate-level research completed under faculty supervision.
Equivalent to: Z 501
This course is repeatable for 16 credits.

IB 503, THESIS, 1-16 Credits
Master’s thesis, completed under faculty supervision.
Equivalent to: Z 503
This course is repeatable for 999 credits.

IB 505, READING AND CONFERENCE, 1-16 Credits
For graduate students working toward a master’s degree. After arrangements with individual faculty, readings and discussions on topics of mutual interest.
Equivalent to: Z 505
This course is repeatable for 16 credits.

IB 506, PROJECTS: OUTREACH, 1-16 Credits
Graded P/N.
Equivalent to: BI 506
This course is repeatable for 16 credits.

IB 507, SEMINAR, 1-16 Credits
Graded P/N.
Equivalent to: Z 507
This course is repeatable for 16 credits.

IB 510, INTERNSHIP, 1-16 Credits
Equivalent to: Z 510
This course is repeatable for 16 credits.

IB 511, INTEGRATIVE BIOLOGY GRADUATE STUDENT ORIENTATION, 2 Credits
Introduction to the graduate program in Integrative Biology and at OSU in general. Class introduces students to various skills for success in graduate school and beyond. Exploration of career options for those holding a degree in IB are explored. Graded P/N.

IB 512, INTEGRATIVE BIOLOGY GTA TRAINING AND DEVELOPMENT, 1 Credit
Provides instructional support and professional development for first year graduate teaching assistants (GTAs) in Integrative Biology. Focuses on developing a foundation for quality instruction, facilitation, and leadership as GTAs and professionals. Best practices, skills, theory and knowledge necessary for effective teaching, facilitation, and assessment of student learning are explored.
This course is repeatable for 3 credits.

IB 513, GRANT WRITING AND ETHICS, 3 Credits
Participants will write and submit a grant proposal by the end of the term. We discuss the main components of a typical grant proposal. Participants read and critique proposal drafts written by participants. Ethical issues are discussed as they are encountered.
Equivalent to: Z 585
This course is repeatable for 6 credits.

IB 515, SCIENCE COMMUNICATION: MAKING YOUR SCIENCE MATTER, 2 Credits
A practical, hands-on course designed to help science graduate students build knowledge and skills for engaging with audiences beyond their scientific peers. The science of science communication, the cultures of journalism and public policy, the changing roles of scientists in society, and science advocacy will be explored through lectures, invited talks, in-class discussions and exercises.

IB 518, SCIENCE AND POLICY, 2 Credits
An introduction to the science-policy interface in a ’post-truth’ society. The formulation of state and federal public policy is examined, as well as and role of science and scientist in informing policy, management decisions and public understanding. Current topics are emphasized.
IB 522, COMPARATIVE/FUNCTIONAL VERTEBRATE ANATOMY, 5 Credits
Phylogenetically-based study of the form and function of vertebrate organ systems, including integumentary, musculoskeletal, cardiopulmonary, digestive, and sensory. Lab emphasizes comparative form through dissection, and function through non-invasive experimentation. Lec/lab.
Equivalent to: Z 522

IB 523, ENVIRONMENTAL PHYSIOLOGY, 3 Credits
Comparative environmental physiology of animals with emphasis on adaptations to such aspects of the physical environment as temperature, water, ions, and gases. Consideration given to interactions between physiology and environment that influence the local and geographic distribution of animals.
Equivalent to: Z 523

IB 525, EMBRYOLOGY AND DEVELOPMENT, 5 Credits
Equivalent to: Z 525

IB 527, PALEOBIOLOGY, 0-4 Credits
Fossils provide a direct window into the evolution, extinction, and ecology of past life on Earth. A process-based study of the marine and terrestrial fossil record is taken to explore the topics of preservation, macroevolution, extinction of biotas, biomechanics, paleoecology, and climate change. Required laboratory and weekend field trip.
Equivalent to: BI 527

IB 531, VERTEBRATE PHYSIOLOGY I, 4 Credits
Systems/concepts covered include motor reflexes, autonomic nervous system, digestion/metabolism, renal and osmoregulatory, endocrine and reproductive systems. First in IB 531, IB 532 series.

IB 532, VERTEBRATE PHYSIOLOGY II, 3 Credits
Systems/concepts covered include blood, immune, lymphatic, cardiovascular, and pulmonary. Second in the IB 531, IB 532 series.
Equivalent to: Z 532

IB 538, BEHAVIORAL NEUROBIOLOGY, 3 Credits
Equivalent to: Z 538

IB 540, INSECT PHYSIOLOGY, 3 Credits
Fundamentals of insect physiology from the behavioral to the molecular level. Cellular physiology and hormonal control of molting, metamorphosis and reproduction. Overview of body functions: respiration, circulation, digestion, metabolism, and osmoregulation. Physiological basis of behavior: muscles and flight, structure and functions of the nervous system, sensory physiology and chemical communication. The contributions of insect physiology to general physiological principles and biorational methods of insect pest control are discussed.
Equivalent to: Z 540

IB 545, EVOLUTION, 3 Credits
Formal analysis of genetic and ecological mechanisms producing evolutionary change; special topics include speciation, ecological constraints, adaptive radiations, paleontology, biogeography, the origin of life, molecular evolution, and human evolution.
Equivalent to: BI 545

IB 551, FUNCTIONAL ANATOMY OF THE HUMAN MUSCULAR SYSTEM, 4 Credits
In-depth dissection of the orientation, innervation, and functional significance of muscles and muscle groups. Topics include muscle identification, joint anatomy and variation of human form. IB 551 student expectations include vascularization and detailed joint anatomy. The laboratory component will consist of the dissection of the muscular anatomy of a human cadaver. Lab fee. Lec/lab.
Equivalent to: BI 551
Recommended: (BI 231 and 241) or (BI 331 and 341)) and ((BI 232 and 242) or (BI 332 and 342)) and ((BI 233 and 243) or (BI 333 and 343))

IB 554, EVOLUTIONARY GENOMICS, 3 Credits
Examines the evolutionary forces that have produced such varied and complex genomes across the tree of life. The processes by which genomes can be structured, maintained, and remodeled (by nature or by humans) are explored through scientific literature. Special emphasis will be given to recent technological advances in genomics, along with their potential impacts on individuals and society.

IB 556, PHYLOGENETICS, 4 Credits
Explores the theory and practice of modern phylogenetic analysis. Emphasis placed on tree reconstruction algorithms, assessment of statistical support, and contemporary issues in phylogenetics. Lab will focus on the use of phylogenetic software and the analysis of molecular data sets. Lec/lab.
Equivalent to: BI 556

IB 561, MARINE AND ESTUARINE INVERTEBRATE ZOOLOGY, 4 Credits
Comparative survey of eight major invertebrate phyla and many lesser-known phyla. Areas of emphasis will be 1) invertebrate identification, 2) natural history (diversity, habitat, feeding, behavior), and 3) comparative anatomy (adaptive significance of morphological structures). Laboratories and field trips will strongly supplement lecture material. Lec/lab. Taught at Hatfield Marine Science Center.
Equivalent to: Z 561
IB 573, HERPETOLOGY, 3 Credits
World families and distribution of amphibians and non-avian sauropods; evolution, population biology, life histories, current literature.
Equivalent to: Z 573

IB 574, SYSTEMATIC HERPETOLOGY, 2 Credits
A survey of the phylogenetic diversity of amphibians and reptiles of the United States. Identification through the use of keys will be stressed. Field trip fee. Lab fee. Lec/lab.
Equivalent to: Z 574

IB 577, AQUATIC ENTOMOLOGY, 4 Credits
Biology, ecology, collection, and identification of aquatic insects. Two required Saturday field trips. Lec/lab.
Equivalent to: Z 577

IB 581, BIOGEOGRAPHY, 3 Credits
Biogeography is the study of the distribution of biodiversity. We focus on abiotic (geological, climatological) and biotic (ecological, evolutionary) factors that govern diversity across space and through time, emphasizing assembly of communities, global change, and conservation in today’s rapidly changing world. The course format includes lecture, computer-based activities, and discussion. Offered winter term in odd years.
Equivalent to: BI 581

IB 583, POPULATION BIOLOGY, 3 Credits
Theoretical and empirical views of the structure and function of populations from across the tree of life, emphasizing the integration of ecological and evolutionary approaches. Lec.
Equivalent to: BI 583

IB 592, THEORETICAL ECOLOGY, 4 Credits
A treatment of the central concepts of theoretical ecology, with emphasis on the analysis and modeling of single populations and multispecies communities. Topics include discrete- and continuous-time models of population growth, stochastic and deterministic processes, and the response of populations and communities to pulse and press perturbations.
Equivalent to: BI 592

IB 593, BEHAVIORAL ECOLOGY, 5 Credits
Behavioral ecology with emphasis on both theoretical and empirical approaches. Offered alternate years.
Equivalent to: Z 593

IB 594, COMMUNITY ECOLOGY, 5 Credits
Theory and analysis of multispecies associations. Emphasis on extent to which existing ecological theory is supported by natural phenomena. Course considers how biotic and abiotic mechanisms interact to regulate community organization and stability in marine, freshwater, and terrestrial habitats. Offered alternate years.
Equivalent to: Z 594

IB 595, DISEASE ECOLOGY, 3 Credits
An introduction to disease ecology—the study of disease processes in natural populations and communities. The course focuses on (I) the role parasites play in the ecology and evolution of animal populations, including humans; and (II) the relevance of ecological and evolutionary considerations in managing infectious diseases.
Equivalent to: BI 595

IB 599, SPECIAL TOPICS, 1-16 Credits
Topics and credits vary. Grading mode TBA. Taught at Hatfield Marine Science Center and Corvallis campus.
Equivalent to: Z 599
This course is repeatable for 16 credits.

IB 601, RESEARCH, 1-16 Credits
Doctoral-level research under faculty supervision. Graded P/N.
Equivalent to: Z 601
This course is repeatable for 16 credits.

IB 603, THESIS, 1-16 Credits
Doctoral thesis completed under faculty supervision.
Equivalent to: Z 603
This course is repeatable for 999 credits.

IB 605, READING AND CONFERENCE, 1-16 Credits
For graduate students working toward doctoral degree. After arrangements with individual faculty, readings and discussions on topics of mutual interest.
Equivalent to: Z 605
This course is repeatable for 16 credits.

Microbiology (MB)

MB 110, ORIENTATION TO MICROBIOLOGY, 1 Credit
Introduction of incoming microbiology students to college life with an emphasis on faculties, facilities, services, and curricula in microbiology. Exposure to career opportunities in microbiology. Graded P/N.

MB 201, LABORATORY SKILLS, 1-16 Credits
These credits are designed for students who are doing experiential learning in a research laboratory on campus, performing basic laboratory tasks that are not elevated to the level of an independent research project. Graded P/N.
This course is repeatable for 16 credits.

MB 230, *INTRODUCTORY MICROBIOLOGY, 4 Credits
Microbiology as it affects our everyday lives. The impact of microorganisms on health, food/water sanitation, environment, industry, and genetic engineering. Lec/lab. (Bacc Core Course)
Attributes: CPBS – Core, Pers, Biological Science
Equivalent to: MB 230H
Available via Ecampus

MB 255, *ALLIED HEALTH MICROBIOLOGY, 4 Credits
General properties of cellular microbes and viruses, microbial biochemistry and genetics, pathogenesis and disease, immunity, and microbial infections. Lecture and lab emphasis is on medical microbiology, infectious diseases, and public health. Not intended for biological sciences majors. Lec/lab. CROSSLISTED as BHS 255/MB 255.
Attributes: CPBS – Core, Pers, Biological Science
Equivalent to: BHS 255
Available via Ecampus
MB 290, SUCCESS IN MICROBIOLOGY, 1 Credit
Science skills, science literacy, ethics, and professional development to build a successful career in Microbiology. Learn the process of research, access and analyze primary literature, evaluate user-generated science content, practice professional skills, and identify and plan for experience-building opportunities such as jobs, research and internships. Sophomore standing or higher.

MB 299, SPECIAL TOPICS, 1-16 Credits
May be repeated for credit when topic varies.  
Equivalent to: MB 299H  
This course is repeatable for 16 credits.

MB 299H, SPECIAL TOPICS, 1-16 Credits
May be repeated for credit when topic varies.  
Attributes: HNRS – Honors Course Designator  
Equivalent to: MB 299  
This course is repeatable for 16 credits.

MB 302, GENERAL MICROBIOLOGY, 3 Credits
Emphasis on cytology, physiology, virology, growth and control of growth with coverage of the role of microorganisms in nature, in disease, and as useful tools.  
Prerequisite: (CH 332 with C- or better or CH 335 with C- or better) and (((BI 212 with C- or better or BI 212H with C- or better) and (BI 213H [C-] or BI 213 [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-]) or (BI 221 [C-] or BI 221H [C-] and (BI 222 [C-] or BI 222H [C-]))  
Available via Ecampus

MB 303, GENERAL MICROBIOLOGY LABORATORY, 2 Credits
Development of laboratory techniques, exercises designed to reinforce concepts covered in MB 302. MB 302 is a prereq that may be taken prior to or concurrently with MB 303. Lec/lab.  
Prerequisite: MB 302 (may be taken concurrently) with D- or better  
Equivalent to: MB 303H  
Recommended: Two terms organic chemistry

MB 310, BACTERIAL MOLECULAR GENETICS, 3 Credits
Introductory concepts of bacterial molecular genetics. Topics include DNA replication, mutation, DNA repair, DNA recombination, transposons, bacteriophages, genetic manipulation, and gene regulation.  
Prerequisite: MB 302 with D- or better and (BB 314 [D-] or BB 314H [D-]) and (BB 450 [D-] or BB 490 [D-]) and (BB 451 (may be taken concurrently) [D-] or BB 491 (may be taken concurrently) [D-])  
Equivalent to: MB 306

MB 311, MOLECULAR MICROBIOLOGY LAB: A WRITING INTENSIVE COURSE, 3 Credits
Scientific writing, laboratory notebook composition, experimental design, and laboratory experiments in bacterial molecular biology. (Writing Intensive Course)  
Attributes: CWIC – Core, Skills, WIC  
Prerequisite: (MB 303 with D- or better or MB 303H with D- or better) and MB 310 (may be taken concurrently) [D-]  
Equivalent to: MB 307

MB 312, BACTERIAL PHYSIOLOGY AND METABOLISM, 3 Credits
Molecular structure and function, macromolecular assembly, energy production and use, and cellular growth.  
Prerequisite: MB 310 with D- or better and BB 451 [D-]  
Equivalent to: MB 304  
Recommended: BB 450

MB 314, AQUATIC MICROBIOLOGY, 3 Credits
A survey of the diversity, ecology, and physiology of microbes in aquatic systems, with emphasis on their roles in food webs, chemical cycling, and human health. Provides the background knowledge and quantitative/analytical skills necessary to interpret and critique current and historical research in the fields of general aquatic microbiology.  
Prerequisite: (CH 231 with D- or better or CH 231H with D- or better or CH 121 with D- or better) and (CH 232 [D-] or CH 232H [D-] or CH 122 [D-]) and (CH 233 [D-] or CH 233H [D-] or CH 123 [D-])  
Available via Ecampus

MB 320, HUMAN BACTERIOLOGY, 4 Credits
Prerequisite: (BI 204 with C- or better and BI 205 [C-] and BI 206 [C-]) or (BI 211 [C-] or BI 211H [C-] and BI 212 [C-] or BI 212H [C-] and BI 213 [C-] or BI 213H [C-]) or (BI 221 [C-] or BI 221H [C-] and (BI 222 [C-] or BI 222H [C-]))  
Equivalent to: BHS 320  
Available via Ecampus

MB 330, *DISEASE AND SOCIETY, 3 Credits
Infectious disease has many effects on the development of society, and likewise, human interactions affect the development of disease. The course examines these interactions with a focus on the role of race, class, and economic status in the development of epidemics. (Bacc Core Course)  
Attributes: CPDP – Core, Perspective, Difference/Power/Discrimination  
Available via Ecampus
MB 340, HUMAN VIROLOGY, 4 Credits
Prerequisite: (BI 204 with C- or better and BI 205 [C-] and BI 206 [C-]) or ((BI 211 [C-] or BI 211H [C-]) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]))
Equivalent to: BHS 340
Available via Ecampus

MB 385, EMERGING INFECTIOUS DISEASES AND EPIDEMICS, 3 Credits
Emerging and reemerging infectious disease is a contemporary global issue of great concern. To understand and evaluate the issue, the course covers germ theory, disease history and ecology, microbial pathogenesis and the immune response, historic plagues, and the biological, environmental, population and social changes that contribute to disease emergence. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (BI 211 with D- or better or BI 211H with D- or better) and (BI 212 [D-] or BI 212H [D-]) and (BI 213 [D-] or BI 213H [D-]) or ((BI 221 [D-] or BI 221H [D-]) and (BI 222 [D-] or BI 222H [D-]) and (BI 223 [D-] or BI 223H [D-]))
Equivalent to: BI 385

MB 399, SPECIAL TOPICS, 1-16 Credits
Equivalent to: MB 399H
This course is repeatable for 16 credits.

MB 399H, SPECIAL TOPICS, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: MB 399
This course is repeatable for 16 credits.

MB 401, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

MB 403, THESIS, 1-16 Credits
This course is repeatable for 16 credits.

MB 405, READING AND CONFERENCE, 1-16 Credits
Conference: Instruction in microbiology.
This course is repeatable for 16 credits.

MB 406, SPECIAL PROJECTS, 1-16 Credits
Reading and Conference/Instructor in Microbiology.
This course is repeatable for 16 credits.

MB 407, SEMINAR, 1-16 Credits
Graded P/N.
This course is repeatable for 16 credits.

MB 410, OCCUPATIONAL INTERNSHIP, 1-10 Credits
Supervised work experience at selected cooperating institutions, agencies, laboratories, clinics or companies. Maximum of 10 credits allowed but no more than 3 credits may be used to satisfy microbiology major requirement of 36 credits. Graded P/N.
This course is repeatable for 10 credits.

MB 416, IMMUNOLOGY, 3 Credits
Basic theory and applications of immunochemistry, immunogenetics, and cellular immunology. Examination of immunologically related diseases.
Prerequisite: BB 450 with D- or better or BB 490 with D- or better

MB 417, IMMUNOLOGY LABORATORY, 2 Credits
Laboratory on the applications of current immunological techniques.
Prerequisite: (MB 303 with D- or better or MB 303H with D- or better) and (MB 303 with D- or better) and (BB 451 [D-] or BB 451H [D-])

MB 420, MICROBIAL GENOMES, BIOGEOCHEMISTRY, AND DIVERSITY, 3 Credits
A survey of microbial diversity from the earliest lifeforms to the modern role of bacteria and archaea in global biogeochemical cycles. Topics covered include molecular evolution, microbial genomics, biochemical diversity, and metabolic pathways that adapt cells to extreme environments. Particular emphasis is placed on marine systems, from photosynthesis in surface waters to life in the ocean crust.
Prerequisite: BB 451 with D- or better

MB 422, AQUATIC MICROBIOLOGY LABORATORY, 2 Credits
Examine patterns of microbiological communities and how those patterns relate to environmental factors. Collect and process samples, analyze the resultant data and present those results. Focus on the microbial ecology of freshwater and marine systems as a foundation for discovery and learning using current analytical techniques.
Prerequisite: MB 303 with D- or better
Corequisites: MB 314

MB 430, BACTERIAL PATHOGENESIS, 3 Credits
Bacteria pathogenic for humans, emphasizing the structural, physiological and genetic mechanisms of pathogenesis. Role of the immune system in pathogenesis and protection.
Prerequisite: MB 302 with D- or better and MB 310 [D-] and (BB 451 [D-] or BB 451H [D-])

MB 434, VIROLOGY, 3 Credits
Properties of viruses, their biology and pathogenesis. Emphasis on viruses causing human disease.
Prerequisite: ((BB 450 with D- or better or BB 450H with D- or better) and (BB 451 [D-] or BB 451H [D-])) or (BB 490 [D-] and BB 491 [D-] and BB 492 [D-])
MB 435, PATHOGENIC MICROBES LABORATORY, 2 Credits
Laboratory experiments to illustrate concepts presented in MB 430 and/ or MB 434, focusing on pathogenic microorganisms.
Prerequisite: (MB 303 with D- or better or MB 303H with D- or better) and MB 302 [D-] and (MB 430 [may be taken concurrently] [D-] or MB 434 [may be taken concurrently] [D-])

MB 436, THE HUMAN MICROBIOME, 3 Credits
Examines the biodiversity, function, and medical importance of the communities of microorganisms that inhabit the human body. A diverse array of topics will be discussed, including how the human microbiome is studied, case studies of specific aspects of the human microbiome, and emerging theories of how the microbiome influences human health.
Prerequisite: BI 314 with D- or better or BB 314 with D- or better or BI 314H with D- or better or MB 302 with D- or better

MB 440, FOOD MICROBIOLOGY, 3 Credits
Role of microorganisms in food spoilage, infection, and intoxication; also basic principles in contamination control and germicidal treatment during processing, preparing, and distributing food for consumption.
Prerequisite: MB 302 with D- or better

MB 441, FOOD MICROBIOLOGY LABORATORY, 2 Credits
Laboratory techniques to accompany MB 440/MB 540.
Prerequisite: (MB 303 with D- or better or MB 303H with D- or better) and MB 440 [may be taken concurrently] [D-]
Recommended: MB 302

MB 448, MICROBIAL ECOLOGY, 3 Credits
A comparison of soil sediments and freshwater as microbial habitats. Discussion of the role of microorganisms in nutrient cycles, effects of microbial activity on plant and animal life.
Prerequisite: MB 302 with D- or better

MB 456, MICROBIAL GENETICS AND BIOTECHNOLOGY, 3 Credits
General biology of natural, genetically engineered, and composite plasmids. Major topics include extrachromosomal DNA replication, plasmid transmission, insertion elements, transposons, gene expression, and recombinant DNA vectors. Biotechnological applications and molecular genetic tools are emphasized.
Prerequisite: MB 302 with D- or better and (BB 450 [D-] or BB 490 [D-]) and (BB 451 [D-] or BB 491 [D-]) and (MB 310 [D-] or BB 492 [D-])

MB 479, FERMENTATION MICROBIOLOGY, 3 Credits
An introduction to industrial microbiology with a focus on the physiology of fermentation and use of microorganisms for the production of food ingredients, fermented foods, and beverages. FST students need to take BB 350 and MB students need to take BB 450 for their respective majors.
CROSSLISTED as FST 479/MB 479 and FST 579/MB 579.
Prerequisite: ((BI 212 with C- or better or BI 212H with C- or better) or ((BI 221 with C- or better or BI 221H with C- or better) and (BI 223 [C-] or BI 223H [C-])) and CH 331 [C-] and CH 332 [C-] and (BB 350 [D-] or BB 450 [D-]) and MB 302 [D-]
Equivalent to: FST 479

MB 480, GENERAL PARASITOLOGY, 3 Credits
Covers a broad overview of parasitology with emphasis on medical parasitology. Explores important groups and host/parasite relationships among all taxa from invertebrates to vertebrates, including mammals.
Prerequisite: ((BI 211 with D- or better or BI 211H with D- or better) and (BI 212 [D-] or BI 212H [D-]) and (BI 213 [D-] or BI 213H [D-])) or ((BI 221 [D-] or BI 221H [D-]) and (BI 222 [D-] or BI 222H [D-]) and (BI 223 [D-] or BI 223H [D-]) or (BI 204 [D-] and BI 205 [D-] and BI 206 [D-])
Available via Ecampus

MB 490, MICROBIOLOGY CAPSTONE EXPERIENCE, 2 Credits
Capstone experience for microbiology students to practice professional skills necessary to sustain a career in science. Students will work in teams to analyze research data and communicate this analysis, in addition to explore career opportunities and learn how to successfully compete for jobs. Graded P/N.
Prerequisite: MB 302 with D- or better

MB 491, FISH DISEASES IN CONSERVATION BIOLOGY AND AQUACULTURE, 3 Credits
Introduction to diseases of fish including pathogens important to aquaculture and ornamental industries as well as to wild fish populations and conservation programs. CROSSLISTED as FW 491/MB 491 and FW 591/MB 591.
Equivalent to: FW 491
Recommended: 9 credits of upper-division fisheries or biology.

MB 496, FISH DISEASES IN CONSERVATION BIOLOGY AND AQUACULTURE LAB, 2 Credits
This laboratory complements lectures in FW/MB 491/591, with students learning basic necropsy techniques; identification of bacterial, viral and metazoan pathogens; and molecular identification methods. CROSSLISTED as FW 496/MB 496 and FW 596/MB 596.
Equivalent to: FW 496
Recommended: MB 303 or other upper-division laboratory course.

MB 499, SPECIAL TOPICS, 0-16 Credits
This course is repeatable for 16 credits.
Recommended: One term of biology

MB 501, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

MB 503, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

MB 505, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

MB 506, SPECIAL PROJECTS, 1-6 Credits
This course is repeatable for 6 credits.
MB 507, SEMINAR, 1 Credit
Graded P/N.
This course is repeatable for 99 credits.

MB 510, INTERNSHIP, 1-16 Credits
This course is repeatable for 16 credits.

MB 511, SCIENTIFIC SKILLS, 1 Credit
Foundational skills for success in graduate school. Students will also become familiar with ongoing research programs in three active programs in the Microbiology Program.

MB 512, HIGHLIGHTS OF MICROBIOLOGY, 1 Credit
Designed for students to gain familiarity with the history of microbiology through reading, reviewing and writing about great papers in the field. Students also meet the Microbiology Program faculty and students, and learn about some of the research in the Microbiology Program through attending colloquium.

MB 513, MICROBIAL SYSTEMS, 3 Credits
Presentation of a modern view of microbiology through the lens of microbes’ influences on our planet’s habitats and inhabitants. Discusses current research and the use of advanced techniques to illustrate how microbiology is contributing to many cross-disciplinary problems that can involve engineering, public health, sociology, ecology, geology, etc.

MB 516, IMMUNOLOGY, 3 Credits
Basic theory and applications of immunochmistry, immunogenetics, and cellular immunology. Examination of immunologically related diseases. Recommended: BB 450 or BB 490

MB 517, IMMUNOLOGY LABORATORY, 2 Credits
Laboratory on the applications of current immunological techniques. Recommended: (MB 303 or MB 303H) and completion or concurrent enrollment in MB 516

MB 520, MICROBIAL GENOMES, BIOGEOCHEMISTRY, AND DIVERSITY, 3 Credits
A survey of microbial diversity from the earliest lifeforms to the modern role of bacteria and archaea in global biogeochemical cycles. Topics covered include molecular evolution, microbial genomics, biochemical diversity, and metabolic pathways that adapt cells to extreme environments. Particular emphasis is placed on marine systems, from photosynthesis in surface waters to life in the ocean crust. Recommended: BB 451 or BB 551

MB 522, AQUATIC MICROBIOLOGY LAB, 2 Credits
Examine patterns of microbial communities and how those patterns relate to environmental factors. Collect and process samples, analyze the resultant data and present those results. Focus on the microbial ecology of freshwater and marine systems as a foundation for discovery and learning using current analytical techniques.

MB 530, BACTERIAL PATHOGENESIS, 3 Credits
Bacteria pathogenic for humans, emphasizing the structural, physiological and genetic mechanisms of pathogenesis. Role of the immune system in pathogenesis and protection. Recommended: MB 302 and MB 310 and (BB 451 or BB 491)

MB 534, VIROLOGY, 3 Credits
Properties of viruses, their biology and pathogenesis. Emphasis on viruses causing human disease. Recommended: ((BB 450 or BB 450H) and (BB 451 or BB 451H)) or (BB 490 and BB 491 and BB 492)

MB 540, FOOD MICROBIOLOGY, 3 Credits
Role of microorganisms in food spoilage, infection, and intoxication; also basic principles in contamination control and germicidal treatment during processing, preparing, and distributing food for consumption. Recommended: MB 302

MB 541, FOOD MICROBIOLOGY LABORATORY, 2 Credits
Laboratory techniques to accompany MB 440/MB 540. Prerequisite: MB 540 (may be taken concurrently) with C or better. Recommended: MB 302 and MB 303

MB 548, MICROBIAL ECOLOGY, 3 Credits
A comparison of soil sediments and freshwater as microbial habitats. Discussion of the role of microorganisms in nutrient cycles, effects of microbial activity on plant and animal life. Recommended: MB 302

MB 555, BIOLOGY OF THE PROKARYOTES, 3 Credits
An integrative graduate course examining bacterial and archaeanal life at different levels of biological organization, emphasizing current research and analysis of primary literature. The various life styles of prokaryotes are the common theme of the course. Topics include biofilms, cooperation and communication, development, stress responses, metabolic interactions involved in global nutrient cycling. Offered every even year in winter term. Recommended: BB 450 and MB 310 and MB 312

MB 556, MICROBIAL GENETICS AND BIOTECHNOLOGY, 3 Credits
General biology of natural, genetically engineered, and composite plasmids. Major topics include extrachromosomal DNA replication, plasmid transmission, insertion elements, transposons, gene expression, and recombinant DNA vectors. Biotechnological applications and molecular genetic tools are emphasized. Recommended: MB 302 and (BB 450 or BB 490) and (BB 451 or BB 491) and (MB 310 or BB 492)
MB 579, FERMENTATION MICROBIOLOGY, 3 Credits
An introduction to industrial microbiology with a focus on the physiology of fermentation and use of microorganisms for the production of food ingredients, fermented foods, and beverages. CROSSLISTED as FST 479/MB 479 and FST 579/MB 579.
Equivalent to: FST 579
Recommended: (BI 212 or BI 212H) or ((BI 221 or BI 221H) and (BI 223 or BI 223H)) and CH 331, CH 332, (BB 350 or BB 450) and MB 302

MB 580, GENERAL PARASITOLOGY, 3 Credits
Covers a broad overview of parasitology with emphasis on medical parasitology. Explores important groups and host/parasite relationships among all taxa from invertebrates to vertebrates, including mammals. Available via Ecampus

MB 591, FISH DISEASES IN CONSERVATION BIOLOGY AND AQUACULTURE, 3 Credits
Introduction to diseases of fish including pathogens important to aquaculture and ornamental industries as well as to wild fish populations and conservation programs. CROSSLISTED as FW 491/MB 491 and FW 591/MB 591.
Equivalent to: FW 591
Recommended: 9 credits of upper-division fisheries or biology.

MB 596, FISH DISEASES IN CONSERVATION BIOLOGY AND AQUACULTURE LAB, 2 Credits
This laboratory complements lectures in FW/MB 491/591, with students learning basic necropsy techniques; identification of bacterial, viral and metazoan pathogens; and molecular identification methods. CROSSLISTED as FW 496/MB 496 and FW 596/MB 596.
Equivalent to: FW 596
Recommended: MB 303 or other upper-division laboratory course.

MB 599, SELECTED TOPICS, 0-6 Credits
This course is repeatable for 24 credits.

MB 601, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

MB 603, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

MB 605, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

MB 607, SEMINAR, 1 Credit
Graded P/N.
This course is repeatable for 99 credits.

MB 610, INTERNSHIP, 1-9 Credits
This course is repeatable for 16 credits.

MB 668, MICROBIAL BIOINFORMATICS AND GENOME EVOLUTION, 4 Credits
Theoretical and practical issues in microbial genome sequencing and annotation, with an emphasis on evolutionary theory and comparative analysis of microbial genome sequences. Metabolic prediction from genomes, with a population genetics perspective on comparative microbial genomics. Exploration of applications of genomics and allied tools to microbial populations, including metagenomics, metaproteomics, and metatranscriptomics.
Equivalent to: MCB 668

MB 699, SPECIAL TOPICS, 0-16 Credits
Lec/lab. This course is repeatable for 16 credits.

Mathematics (MTH)

MTH 065, ELEMENTARY ALGEBRA, 3 Credits
Arithmetic of signed numbers, order of operations, simplifying algebraic expressions, solutions of linear equations, and inequalities. Rules of exponents, addition, subtraction, and multiplication of polynomials, factoring, solution of quadratic equations by factoring, reducing rational expressions. Word problems involving linear equations, graphing of linear equations, inequalities. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: Math Placement Test with a score of 05 or Math Placement - ALEKS with a score of 015
Available via Ecampus

MTH 095, INTERMEDIATE ALGEBRA, 3 Credits
Addition, subtraction, multiplication, and division of rational expressions, long division of polynomials, solutions of fractional equations, applications involving linear equations. Fractional equations, inequalities, literal equations, and variations. Negative and fractional exponents, radicals, solutions of quadratic equations, and complex numbers. Cartesian coordinates, graphs of linear equations and inequalities, distance formula, slope, equations of lines, solutions of systems of linear equations in two unknowns and inequalities. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 065 with C- or better or Math Placement Test with a score of 11 or Math Placement - ALEKS with a score of 015
Available via Ecampus

MTH 102, ALGEBRAIC FOUNDATIONS, 3 Credits
This course is designed primarily for EOP students. They will use various computing technologies to explore realistic and interesting situations in which algebra is used. As they work through explorations, they will work with many of the fundamental ideas of algebra, ideas they will find important in their daily lives.
MTH 103, ALGEBRAIC REASONING, 4 Credits
Graphing data, functions, rate of change, linear equations, systems of linear equations, linear inequalities, linear functions, absolute value functions, quadratic functions, exponential functions. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 065 with C- or better or Math Placement Test with a score of 11 or Math Placement - ALEKS with a score of 030
Available via Ecampus

MTH 105, *INTRODUCTION TO CONTEMPORARY MATHEMATICS, 3 Credits
Elementary linear programming, combinatorics, descriptive statistics, elementary probability, exponential growth and decay, examples of major mathematical ideas and models. Lec/rec. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Recommended: MTH 095 or MTH 103 or (MPT=Math Placement Test score of 17; MPAL=Math Placement Test-ALEKS score of 46%)
Available via Ecampus

MTH 111, *COLLEGE ALGEBRA, 4 Credits
Polynomial equations and inequalities, polynomial functions and graphs, inverse functions, exponential and logarithmic functions, elementary mathematical modeling and applications. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with a C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 095 with C- or better or MTH 103 with C- or better or Math Placement Test with a score of 17 or Math Placement - ALEKS with a score of 046
Available via Ecampus

MTH 112, *ELEMENTARY FUNCTIONS, 4 Credits
Triangle trigonometry, circular functions and graphs, trigonometric equations and identities, inverse trigonometric functions, polar coordinates, vectors and applications. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Equivalent to: MTH 150X
Available via Ecampus

MTH 199, SPECIAL TOPICS, 1-16 Credits
Maximum 3 credits per term, 9 credits total. Does not meet university group requirement in physical science.
This course is repeatable for 9 credits.

MTH 211, *FOUNDATIONS OF ELEMENTARY MATHEMATICS, 4 Credits
Introduction to problem solving, sets, whole numbers, number theory, fractions. Intended primarily for prospective elementary teachers. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 095 with C- or better or MTH 103 with C- or better or MTH 111 with C- or better or MTH 112 with C- or better or Math Placement Test with a score of 17 or Math Placement - ALEKS with a score of 046

MTH 212, FOUNDATIONS OF ELEMENTARY MATHEMATICS, 4 Credits
Math 212 is the second of a three-term sequence of courses designed to help prepare prospective elementary and middle school teachers. Topics covered include fractions, decimals, percent, ratio and proportion, integers, rational numbers, real numbers, probability and statistics.
Prerequisite: MTH 211 with C- or better

MTH 227, *CALCULUS AND PROBABILITY FOR THE LIFE SCIENCES I, 4 Credits
Review of exponential and trigonometric functions, including examples of exponential and periodic behavior; discrete probability; examples of biologically motivated difference equations; differentiation of polynomials, exponential and trigonometric functions with applications to optimization. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 112 with C- or better or MTH 150X with C- or better or Math Placement Test with a score of 33 or Math Placement - ALEKS with a score of 75
Equivalent to: MTH 227X

MTH 228, CALCULUS AND PROBABILITY FOR THE LIFE SCIENCES II, 4 Credits
Continuation of MTH 227 with more general population growth models. Antidifferentiation; The Fundamental Theorem of Calculus applied to solving continuous growth models. Continuous random variables. Basic linear algebra of small systems sufficient to calculate eigenvalues and eigenvectors and appreciate their use in life science applications. Lec/rec.
Prerequisite: MTH 227 with C- or better or MTH 227X with C- or better

MTH 231, ELEMENTS OF DISCRETE MATHEMATICS, 4 Credits
Elementary logic and set theory, functions, direct proof techniques, contradiction and contraposition, mathematical induction and recursion, elementary combinatorics, basic graph theory, minimal spanning trees. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Equivalent to: MTH 231H
Available via Ecampus
MTH 231H, ELEMENTS OF DISCRETE MATHEMATICS, 4 Credits
Elementary logic and set theory, functions, direct proof techniques, contradiction and contraposition, mathematical induction and recursion, elementary combinatorics, basic graph theory, minimal spanning trees. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Equivalent to: MTH 231

MTH 241, *CALCULUS FOR MANAGEMENT AND SOCIAL SCIENCE, 4 Credits
Elementary differential calculus of polynomial, logarithmic, and exponential functions and their applications to business, management and social sciences. Lec/rec. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Available via Ecampus

MTH 245, *MATHEMATICS FOR MANAGEMENT, LIFE, AND SOCIAL SCIENCES, 4 Credits
Techniques of counting, probability and elements of statistics including binomial and normal distributions. Introductory matrix algebra. Elements of linear programming. Lec/rec. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Available via Ecampus

MTH 251H, *DIFFERENTIAL CALCULUS, 4 Credits
Differential calculus for engineers and scientists. Rates of change: the derivative, velocity, and acceleration. The algebraic rules of differential calculus and derivatives of polynomial, rational, and trigonometric functions. Maximum-minimum problems, curve sketching, and other applications. Antiderivatives and simple motion problems. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: CSMA – Core, Skills, Math; HNRS – Honors Course Designator
Prerequisite: MTH 112 with C- or better or MTH 150X with C- or better or Math Placement Test with a score of 33 or Math Placement - ALEKS with a score of 075
Equivalent to: MTH 251

MTH 252, INTEGRAL CALCULUS, 4 Credits
Definite integrals, elementary applications to area, force, and work. Integral tables and basic techniques of integration, calculus of logarithmic and exponential functions, polar coordinates, applications to areas, volumes, force, work, and growth and decay problems. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 251 with C- or better or MTH 251H with C- or better
Equivalent to: MTH 252H
Available via Ecampus

MTH 252H, INTEGRAL CALCULUS, 4 Credits
Definite integrals, elementary applications to area, force, and work. Integral tables and basic techniques of integration, calculus of logarithmic and exponential functions, polar coordinates, applications to areas, volumes, force, work, and growth and decay problems. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 251 with C- or better or MTH 251H with C- or better
Equivalent to: MTH 252

MTH 253, INFINITE SERIES AND SEQUENCES, 4 Credits
Indeterminate forms. Improper integrals. Sequences and series, especially Taylor’s formula and power series. Applications to numerical estimation with error analysis. Series with complex terms and the Euler identities. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 253H

MTH 254, VECTOR CALCULUS I, 4 Credits
Vectors, vector functions, and curves in two and three dimensions. Surfaces, partial derivatives, gradients, and directional derivatives. Multiple integrals in rectangular, polar, cylindrical, and spherical coordinates. Physical and geometric applications. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 254H
Available via Ecampus
MTH 254H, VECTOR CALCULUS I, 4 Credits
Vectors, vector functions, and curves in two and three dimensions. Surfaces, partial derivatives, gradients, and directional derivatives. Multiple integrals in rectangular, polar, cylindrical, and spherical coordinates. Physical and geometric applications. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 254

MTH 255, VECTOR CALCULUS II, 4 Credits
Brief review of vector functions, space curves, gradients, and directional derivatives. Introduction to vector analysis: vector fields, divergence, curl, line integrals, surface integrals, conservative fields, and the theorems of Gauss and Stokes with applications to force, work, mass, and charge. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Equivalent to: MTH 255H

MTH 255H, VECTOR CALCULUS II, 4 Credits
Brief review of vector functions, space curves, gradients, and directional derivatives. Introduction to vector analysis: vector fields, divergence, curl, line integrals, surface integrals, conservative fields, and the theorems of Gauss and Stokes with applications to force, work, mass, and charge. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Equivalent to: MTH 255

MTH 256, APPLIED DIFFERENTIAL EQUATIONS, 4 Credits
First order linear and nonlinear equations, and second order linear equations. Applications to electric circuits and mechanical oscillators. Introduction to the Laplace transform and higher order equations. Solution methods and applications appropriate for science and engineering. (Familiarity with complex numbers and Euler’s identities is highly desirable.) Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Equivalent to: MTH 256H
Available via Ecampus

MTH 256H, APPLIED DIFFERENTIAL EQUATIONS, 4 Credits
First order linear and nonlinear equations, and second order linear equations. Applications to electric circuits and mechanical oscillators. Introduction to the Laplace transform and higher order equations. Solution methods and applications appropriate for science and engineering. (Familiarity with complex numbers and Euler’s identities is highly desirable.) All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Equivalent to: MTH 256

MTH 264, INTRODUCTION TO MATRIX ALGEBRA, 2 Credits
Introduction to matrix algebra: systematic solution to systems of linear equations; linear transformations; eigenvalue problems.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 264H
Available via Ecampus

MTH 264H, INTRODUCTION TO MATRIX ALGEBRA, 2 Credits
Introduction to matrix algebra: systematic solution to systems of linear equations; linear transformations; eigenvalue problems.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 264

MTH 265, INTRODUCTION TO SERIES, 2 Credits
Convergence and divergence of numerical series, including geometric series. Series of functions. Power series and their analytic properties. Taylor series expansions and Taylor polynomials.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Available via Ecampus

MTH 265H, INTRODUCTION TO SERIES, 2 Credits
Convergence and divergence of numerical series, including geometric series. Series of functions. Power series and their analytic properties. Taylor series expansions and Taylor polynomials.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 265

MTH 299, SPECIAL TOPICS, 0-16 Credits
Maximum 3 credits per term, 9 credits total. This course is repeatable for 9 credits.

MTH 306, MATRIX AND POWER SERIES METHODS, 4 Credits
Introduction to matrix algebra, determinants, systematic solution to linear systems, and eigenvalue problems. Convergence and divergence of series with emphasis on power series, Taylor series expansions, convergence tests for power series, and error estimates for truncated series used in practical approximations. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 306H
MTH 306H, MATRIX AND POWER SERIES METHODS, 4 Credits
Introduction to matrix algebra, determinants, systematic solution to linear systems, and eigenvalue problems. Convergence and divergence of series with emphasis on power series, Taylor series expansions, convergence tests for power series, and error estimates for truncated series used in practical approximations. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 306

MTH 311, ADVANCED CALCULUS I, 4 Credits
Rigorous development of calculus, axiomatic properties of the real numbers, topology of the real line, convergence of sequences and series of real numbers, functions, limits of functions, basic properties of continuity and derivatives. Brief treatment of Riemann integration, improper integrals, sequences of functions, pointwise and uniform convergence, introductory aspects of multivariable calculus. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 254 with C- or better or MTH 254H with C- or better) and MTH 355 [C-]

MTH 312, ADVANCED CALCULUS II, 4 Credits
Rigorous development of calculus, axiomatic properties of R, topology of the real line, convergence of sequences and series of real numbers, functions, limits of functions, basic properties of continuity and derivatives. Brief treatment of Riemann integration, improper integrals, sequences of functions, pointwise and uniform convergence, introductory aspects of multivariable calculus. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 311 with C- or better

MTH 321, INTRODUCTORY APPLICATIONS OF MATHEMATICAL SOFTWARE, 3 Credits
An introduction to select mathematical software packages to support problem solving and applications. Topics include using computational resources to solve basic numerical and symbolic problems in mathematics, visualization and presentation of data, creation of simple programming scripts, and applications of basic programming techniques to promote mathematical understanding. The scientific typesetting language LaTeX will also be covered. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 341 with C- or better or (MTH 264 with C- or better or MTH 264H with C- or better) or (MTH 306 with C- or better or MTH 306H with C- or better)

MTH 323, ^MATHEMATICAL MODELING, 3 Credits
A variety of mathematical modeling techniques will be introduced. Students will formulate models in response to practical problems drawn from the literature of ecology, environmental sciences, engineering or other fields. Informal writing assignments in class and formal written presentation of the models will be required. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

MTH 333, ^FUNDAMENTAL CONCEPTS OF TOPOLOGY, 3 Credits
Open and closed sets, continuity, compactness, connectedness, winding number, fixed point theorems in the plane. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: MTH 341 with C- or better or MTH 355 with C- or better

MTH 338, ^NON-EUCLIDEAN GEOMETRY, 3 Credits
Introduction to non-Euclidean geometries. Selected topics such as hyperbolic and elliptic geometry, spherical geometry, projective geometry, geometries arising from alternative metrics. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: MTH 341 (may be taken concurrently) with C- or better

MTH 341, LINEAR ALGEBRA I, 3 Credits
Matrix algebra, determinants, systems of linear equations, subspaces, an introductory study of eigenvalues and eigenvectors. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Available via Ecampus

MTH 342, LINEAR ALGEBRA II, 4 Credits
Abstract (real or complex) vector spaces, linear transformations, inner product spaces, orthogonality, eigenspaces and diagonalization, spectral theorems, singular value decomposition. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 341 with C- or better

MTH 343, INTRODUCTION TO MODERN ALGEBRA, 4 Credits
Introduction to algebraic abstraction, with an emphasis on structures and logical communication by way of proofs. Material includes an introduction to groups, rings and fields. Emphasis is on symmetry groups, the integers as a ring, and polynomial rings; selected applications. Generalizing from examples to mathematical statements, reading proofs, and both creating and editing proofs. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 341 with C- or better and MTH 355 [C-]
MTH 351, INTRODUCTION TO NUMERICAL ANALYSIS, 3 Credits
Introduction to the computation of approximate solutions to mathematical problems that cannot be solved by hand: analysis of errors; rootfinding for nonlinear equations in one variable; interpolation of functions; numerical integration. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 253 with C- or better or (MTH 306 with C- or better or MTH 306H with C- or better) or ((MTH 264 with C- or better or MTH 264H with C- or better) and (MTH 265 [C-] or MTH 265H [C-]))
Recommended: Programming experience

MTH 355, DISCRETE MATHEMATICS, 3 Credits
Proof analysis and development in the context of discrete mathematics for math majors transitioning to upper-division course work. Topics include elementary logic and set theory, quantifiers, basic counting principles, elementary combinatorics, equivalence relations, the binomial theorem, and mathematical induction. Additional topics may include recurrence relations, generating functions, and introductory graph theory. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 253 with C- or better
Recommended: MTH 341

MTH 361, INTRODUCTION TO PROBABILITY, 3 Credits
Probability problem solving using concepts developed in calculus. Topics include probability models, discrete and continuous random variables, expectation and variance, the law of large numbers, and the central limit theorem. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 253 with C- or better or (MTH 306 with C- or better or MTH 306H with C- or better) or (MTH 265 with C- or better or MTH 265H with C- or better)
Equivalent to: MTH 361H

MTH 360, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

MTH 365, PROJECTS, 1-3 Credits
Graded P/N. This course is repeatable for 16 credits.

MTH 367, SEMINAR, 3 Credits
This course is repeatable for 99 credits.

MTH 401, OCCUPATIONAL INTERNSHIP, 3-12 Credits
Planned and supervised training experience at selected government, industrial, or business placement sites. Must be followed by a one-hour post-internship seminar. Consult departmental head advisor. Graded P/N. This course is repeatable for 16 credits.

MTH 402, REAL ANALYSIS, 3 Credits
Properties of metric spaces and normed spaces, including $l^p$ spaces. Completeness and applications, including fixed point theorems. Compactness. Equicontinuity and the Arzela-Ascoli theorem. Uniform continuity and uniform convergence, including applications.
Prerequisite: MTH 312 with B+ or better and MTH 341 [B+]
This course is repeatable for 18 credits.

MTH 403, REAL ANALYSIS, 3 Credits
Measure and integration theory, basic convergence theorems, $L^p$ spaces, Fubini’s theorem, Radon-Nikodym theorem, and applications. Banach spaces including Baire category theorems, and Hilbert spaces.
Prerequisite: MTH 402 with C- or better or MTH 501 with C- or better
This course is repeatable for 18 credits.

MTH 404, REAL ANALYSIS, 3 Credits
Measure and integration theory, basic convergence theorems, $L^p$ spaces, Fubini’s theorem, Radon-Nikodym theorem, and applications. Banach spaces including Baire category theorems, and Hilbert spaces.
Prerequisite: MTH 403 with C- or better or MTH 501 with C- or better
This course is repeatable for 18 credits.

MTH 405, MULTIVARIABLE ADVANCED CALCULUS, 3 Credits
A rigorous development of multivariable advanced calculus, including continuity and compactness in multivariable Euclidean spaces, differentiation and approximation of multivariable functions, the inverse function theorem and the implicit function theorem, integration in several variables.
Prerequisite: MTH 312 with B or better
MTH 420, MODELS AND METHODS OF APPLIED MATHEMATICS, 3 Credits
Discrete and continuous mathematical models and methods for analysis, including linear analysis, equilibrium and minimum principles, calculus of variations, principal component analysis and orthogonal expansions, asymptotic and Fourier analysis, least squares, constrained and unconstrained optimization, inverse problems, and Monte Carlo techniques. Particular models and methods covered may vary annually. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

MTH 427, INTRODUCTION TO MATHEMATICAL BIOLOGY, 3 Credits
Modeling and mathematical analysis of biological processes using first principles at scales ranging from the molecular to the population level. Deterministic models are studied in both discrete and continuous time and analyzed using linearization principles, linear and nonlinear stability techniques, phase plane methods, and methods from partial differential equations. Results obtained from mathematical analysis will be qualitatively interpreted and applied to the biological process under investigation. All courses used to satisfy MTH prerequisites must be completed with a C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

MTH 428, STOCHASTIC ELEMENTS IN MATHEMATICAL BIOLOGY, 3 Credits
An introduction to stochastic modeling of biological processes. The stochastic models covered may include Markov processes in both continuous and discrete time, urn models, branching processes, and coalescent processes. The biological applications may include genetic drift, population dynamics, genealogy, demography, and epidemiology. Mathematical results will be qualitatively interpreted and applied to the biological process under investigation.
Prerequisite: MTH 341 with C or better and (MTH 361 [C] or MTH 463 [C] or MTH 563 [C])

MTH 430, METRIC SPACES AND TOPOLOGY, 3 Credits
Fundamental notions of metric space topology. Examples of Euclidean, non-Euclidean and other fundamental metric spaces including the Hilbert Cube and two-dimensional surfaces. Characterization and classification results for metric spaces. Selected applications of topology, possibly including the structure of molecules and/or networks. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 311 with C- or better
Recommended: MTH 311

MTH 434, INTRODUCTION TO DIFFERENTIAL GEOMETRY, 3 Credits
Curves and surfaces in Euclidean space; geodesics; curvature; introduction to tensor algebra and differential forms; selected applications. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 255 with C- or better or MTH 255H with C- or better) and MTH 342 [C-]
Recommended: MTH 311

MTH 435, DIFFERENTIAL GEOMETRY, 3 Credits
Differentiable 2-manifolds; curvature; geodesics; tensor algebra and the algebra of exterior differential forms with emphasis on Euclidean space; differentiation of tensors and forms; integration of forms; selected applications. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 434 with C- or better or MTH 534 with C- or better

MTH 437, GENERAL RELATIVITY, 3 Credits
Geometry of special relativity. Tensor analysis, metrics, geodesics, curvature. Einstein field equations, cosmological models, black holes. Selected topics such as global structure, conserved quantities, spinors. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 434 with C- or better or MTH 534 with C- or better)
Recommended: MTH 311

MTH 440, COMPUTATIONAL NUMBER THEORY, 3 Credits
Development of the number theory used in some basic tests of primality and methods of factoring integers. Applications to cryptography. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 231 with C- or better or MTH 231H with C- or better or MTH 343 with C- or better or MTH 355 with C- or better

MTH 441, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits
Applications of fundamental algebraic systems to topics such as factorization of polynomials, finding roots of polynomials, error correcting codes. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 343 with C- or better and (MTH 342 [C-] or MTH 440 [C-] or MTH 540 [C-])

MTH 442, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits
Applications of fundamental algebraic systems to topics such as factorization of polynomials, finding roots of polynomials, error correcting codes. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 441 with C- or better or MTH 541 with C- or better
MTH 443, ABSTRACT LINEAR ALGEBRA, 3 Credits
Abstract vector spaces. Linear transformations, eigenvalues and eigenvectors, the Jordan canonical form, inner product spaces. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 342 with C- or better or MTH 343 with C- or better

MTH 451, NUMERICAL LINEAR ALGEBRA, 3 Credits
Computation of solutions of linear systems using direct and iterative methods; least-squares solution of overdetermined systems; computation of eigenvalues and eigenvectors. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 341 with C- or better
Recommended: Programming experience, MTH 342 and MTH 351

MTH 452, NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Numerical solution of initial-value problems using Runge-Kutta methods and linear multistep methods; introduction to boundary-value problems. Analysis of stability, accuracy, and implementation of methods. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 256 with C- or better and MTH 256H with C- or better) or (MTH 306 with C- or better or MTH 306H with C- or better) or MTH 341 with C- or better (and (MTH 264 with C- or better or MTH 264H with C- or better)) or (MTH 253 with C-) or (MTH 253H with C-)
Recommended: MTH 351 or MTH 451 or MTH 551

MTH 453, NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Numerical solution of boundary value problems and initial-boundary value problems using finite difference and finite element methods. Analysis of stability, accuracy, and implementation of methods. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 452 with C- or better or MTH 552 with C- or better

MTH 463, PROBABILITY I, 3 Credits
An introduction to probability theory; topics covered include: the axioms of probability, probability spaces and models, independence, random variables; densities, distributions, expectation, and variance; probability inequalities, the law of large numbers, and the binomial central limit theorem. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 311 (may be taken concurrently) with C- or better

MTH 464, PROBABILITY II, 3 Credits
Transformations of random variables; sums of independent random variables, generating functions, characteristic functions, the central limit theorem and other weak limit theorems. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 463 with C- or better or MTH 563 with C- or better) and MTH 341 [C-]

MTH 465, PROBABILITY III, 3 Credits
Random variables, central limit theorem; distributions of standard statistics; Markov chains, continuous and discontinuous stochastic processes. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 464 with C- or better or MTH 564 with C- or better

MTH 467, ACTUARIAL MATHEMATICS, 3 Credits
Foundations of actuarial science from the point of view of mathematical models that arise in the design and management of insurance systems. Most models will be life insurance based. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 463 with C- or better or MTH 563 with C- or better or ST 421 with C- or better

MTH 480, SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Systems of two first-order differential equations, phase portraits, linearization and the stability of equilibria, conservative systems, reversible systems, limit cycles and the Poincare-Bendixson Theorem. Additional topics selected from Hamiltonian systems, Hopf bifurcation or Lorenz equations and chaos. MTH 480 and MTH 481 cannot both be taken for credit. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

MTH 481, APPLIED ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Linear and nonlinear systems of ordinary differential equations, elementary stability theory, higher order equations, boundary value problems, series solution of ordinary differential equations. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and (MTH 253 with C- or better or MTH 253H with C- or better) or (MTH 264 with C- or better or MTH 264H with C- or better) or (MTH 253 with C-) or (MTH 253H with C-) or (MTH 256 with C-) or (MTH 256H with C-)
Recommended: MTH 351 or MTH 451 or MTH 551

MTH 482, APPLIED PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Partial differential equations, Bessel's and Legendre's equations, Fourier analysis, separation of variables, transform methods. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

MTH 483, COMPLEX VARIABLES, 3 Credits
Introduction to the complex differential and integral calculus: Cauchy's theorem and formula, the residue calculus, power series and Laurent series, harmonic functions, conformal mapping, and applications. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and (MTH 253 with C-) or (MTH 306 with C-) or (MTH 306H with C-) or (MTH 265 with C-) or (MTH 265H with C-).
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<td>MTH 513</td>
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<td>MTH 520</td>
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<td>MTH 524</td>
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**Prerequisites and Recommendations:**
- MTH 341 with C- or better
- MTH 361
- MTH 491 with C- or better or MTH 591 with C- or better
- MTH 492 with C- or better or MTH 592 with C- or better
- MTH 312 and MTH 341
- MTH 256 or MTH 256H
- MTH 341 and MTH 342 and MTH 311 and MTH 312 and
- MTH 256
- MTH 311 and MTH 312 and MTH 361
MTH 525, DYNAMICAL SYSTEMS THEORY AND APPLICATIONS, 3 Credits
Theory, models, and problems for discrete and/or continuous dynamical systems. Depending on term, the emphasis may be toward deterministic or stochastic systems. Topics generally include stability theory, periodic behavior, and chaotic systems. Models selected from biology, economics, fluid dynamics, and electrical and mechanical systems. May be repeated once for credit with a different topic. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 6 credits.
Recommended: MTH 341 and MTH 342 and MTH 311 and MTH 312 and MTH 361

MTH 527, INTRODUCTION TO MATHEMATICAL BIOLOGY, 3 Credits
Modeling and mathematical analysis of biological processes using first principles at scales ranging from the molecular to the population level. Deterministic models are studied in both discrete and continuous time and analyzed using linearization principles, linear and nonlinear stability techniques, phase plane methods, and methods from partial differential equations. Results obtained from mathematical analysis will be qualitatively interpreted and applied to the biological process under investigation. All courses used to satisfy MTH prerequisites must be completed with a C or better.
Recommended: (MTH 256 or MTH 256H) and MTH 341

MTH 528, STOCHASTIC ELEMENTS IN MATHEMATICAL BIOLOGY, 3 Credits
An introduction to stochastic modeling of biological processes. The stochastic models covered may include Markov processes in both continuous and discrete time, urn models, branching processes, and coalescent processes. The biological applications may include genetic drift, population dynamics, genealogy, demography, and epidemiology. Mathematical results will be qualitatively interpreted and applied to the biological process under investigation. All courses used to satisfy MTH prerequisites must be completed with a C or better.
Recommended: MTH 341 and (MTH 361 or MTH 463 or MTH 563)

MTH 531, GENERAL TOPOLOGY AND FUNDAMENTAL GROUPS, 3 Credits
Topological spaces and maps. Separation axioms, compactness, convergence, extension theorems, metrizability and compactification. Product spaces and simplicial complexes. Definition and basic properties of the fundamental group functor, with applications to the theory of covering spaces. Selected topics from dimension theory, manifold theory, and other areas of topology. All courses used to satisfy MTH prerequisites must be completed with C or better.

MTH 532, GENERAL TOPOLOGY AND FUNDAMENTAL GROUPS, 3 Credits
Topological spaces and maps. Separation axioms, compactness, convergence, extension theorems, metrizability and compactification. Product spaces and simplicial complexes. Definition and basic properties of the fundamental group functor, with applications to the theory of covering spaces. Selected topics from dimension theory, manifold theory, and other areas of topology. All courses used to satisfy MTH prerequisites must be completed with C or better.

MTH 534, INTRODUCTION TO DIFFERENTIAL GEOMETRY, 3 Credits
Curves and surfaces in Euclidean space; geodesics; curvature; introduction to tensor algebra and differential forms; selected applications. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: (MTH 255 or MTH 255H) and MTH 342 and MTH 311

MTH 535, DIFFERENTIAL GEOMETRY, 3 Credits
Differentiable 2-manifolds; curvature; geodesics; tensor algebra and the algebra of exterior differential forms with emphasis on Euclidean space; differentiation of tensors and forms; integration of forms; selected applications. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 434 or MTH 534

MTH 537, GENERAL RELATIVITY, 3 Credits
Geometry of special relativity. Tensor analysis, metrics, geodesics, curvature. Einstein field equations, cosmological models, black holes. Selected topics such as global structure, conserved quantities, spinors. All courses used to satisfy MTH prerequisites must be completed with C or better.
Prerequisite: MTH 443 with C or better or MTH 534 with C or better
Recommended: MTH 311

MTH 540, COMPUTATIONAL NUMBER THEORY, 3 Credits
Development of the number theory used in some basic tests of primality and methods of factoring integers. Applications to cryptology. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 231 or MTH 343 or MTH 355

MTH 541, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits
Applications of fundamental algebraic systems to topics such as factorization of polynomials, finding roots of polynomials, error correcting codes. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 343 and (MTH 342 or MTH 440 or MTH 540)

MTH 542, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits
Applications of fundamental algebraic systems to topics such as factorization of polynomials, finding roots of polynomials, error correcting codes. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 441 or MTH 541

MTH 543, ABSTRACT LINEAR ALGEBRA, 3 Credits
Abstract vector spaces. Linear transformations, eigenvalues and eigenvectors, the Jordan canonical form, inner product spaces. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 342 and MTH 343
MTH 551, NUMERICAL LINEAR ALGEBRA, 3 Credits
Computation of solutions of linear systems using direct and iterative methods; least-squares solution of overdetermined systems; computation of eigenvalues and eigenvectors. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 341, MTH 342, MTH 351 and programming experience.

MTH 552, NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Numerical solution of initial-value problems using Runge-Kutta methods and linear multistep methods; introduction to boundary-value problems. Analysis of stability, accuracy, and implementation of methods. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: Programming experience and (MTH 256 or MTH 256H) and (MTH 306 or MTH 306H or MTH 341) and (MTH 351 or MTH 451 or MTH 551).

MTH 553, NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Numerical solution of boundary value problems and initial-boundary value problems using finite difference and finite element methods. Analysis of stability, accuracy, and implementation of methods. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 452 or MTH 552.

MTH 557, ACTUARIAL MATHEMATICS, 3 Credits
Foundations of actuarial science from the point of view of mathematical models that arise in the design and management of insurance systems. Most models will be life insurance based. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: (MTH 463 or MTH 563) or ST 421.

MTH 567, PROBABILITY I, 3 Credits
Key ideas in probability, data analysis, and statistics critical for the mathematics content knowledge of elementary teachers in grades K-8. Based on the recommendations of The Mathematical Education of Teachers by the Conference Board of the Mathematical Sciences. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 390.

MTH 568, PROBABILITY AND DATA ANALYSIS IN K-8 MATHEMATICS, 3 Credits
Introduction to probability and data analysis, and statistics critical for the mathematics content knowledge of elementary teachers in grades K-8. Based on the recommendations of The Mathematical Education of Teachers by the Conference Board of the Mathematical Sciences. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 390.

MTH 578, APPLY ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Linear and nonlinear systems of ordinary differential equations, elementary stability theory, higher order equations, boundary value problems, series solution of ordinary differential equations. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: (MTH 256 or MTH 256H) and (MTH 253 or MTH 253H) or (MTH 341) or (MTH 306 or MTH 306H).

MTH 582, APPLIED PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Partial differential equations, Bessel's and Legendre's equations, Fourier analysis, separation of variables, transform methods. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 480 or MTH 481 or MTH 581.

MTH 583, COMPLEX VARIABLES, 3 Credits
Introduction to the complex differential and integral calculus: Cauchy's theorem and formula, the residue calculus, power series and Laurent series, harmonic functions, conformal mapping, and applications. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: (MTH 256 or MTH 256H) and (MTH 253 or MTH 253H) or (MTH 341) or (MTH 306 or MTH 306H).

MTH 590, TOPICS IN SECONDARY MATHEMATICS, 3 Credits
Key ideas and topics in discrete mathematics critical for the mathematics content knowledge of middle and high school teachers in grades 6-12. Based on the recommendations of The Mathematical Education of Teachers by the Conference Board of the Mathematical Sciences. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 390.
MTH 591, ALGEBRA AND GEOMETRIC
TRANSFORMATIONS, 3 Credits
Ordered fields, number systems (natural, integer, rational, real, and
complex), fundamental theorems of arithmetic and algebra, algebraic
and transcendental numbers, constructible points and numbers and the
classical geometric constructions, Polya's problem solving heuristics and
strategies. Intended primarily for prospective mathematics teachers. All
courses used to satisfy MTH prerequisites must be completed with C or
better.
Recommended: MTH 341

MTH 592, ALGEBRA AND GEOMETRIC
TRANSFORMATIONS, 3 Credits
Major results of Euclidean geometry, axiom systems for Euclidean
geometry, dependency tree of Euclidean theorems, groups of geometric
transformations with applications to symmetries of plane and solid
objects, Euler's formula, tilings and tessellations, isometries and
similitudes of the plane (translations, rotations, reflections, glide
reflections, dilations). Intended primarily for prospective mathematics
teachers. All courses used to satisfy MTH prerequisites must be
completed with C or better.
Recommended: MTH 491 or MTH 591

MTH 593, ALGEBRA AND GEOMETRIC
TRANSFORMATIONS, 3 Credits
Geometric transformations as real, complex, and matrix functions,
invariants and genealogy of geometric transformations, extensions to
transformations of the sphere and of three-dimensional space, selected
applications chosen from fractals, analysis of frieze and crystallographic
patterns, problem solving, groups of symmetries, computer graphics, and
the use of dynamic geometry software. Intended primarily for prospective
mathematics teachers. All courses used to satisfy MTH prerequisites
must be completed with C or better.
Recommended: MTH 492 or MTH 592

MTH 598, PROBABILITY AND DATA
ANALYSIS IN SECONDARY MATHEMATICS,
3 Credits
Key ideas and topics in probability, data analysis, and statistics critical for
the mathematics content knowledge of middle and high school teachers
in grades 6-12. Based on the recommendations of The Mathematical
Education of Teachers by the Conference Board of the Mathematical
Sciences. All courses used to satisfy MTH prerequisites must be
completed with C or better.
Recommended: MTH 390

MTH 599, SPECIAL TOPICS, 0-16 Credits
Topics may vary.
This course is repeatable for 18 credits.

MTH 601, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

MTH 603, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

MTH 605, READING AND CONFERENCE,
1-16 Credits
This course is repeatable for 16 credits.

MTH 606, SPECIAL PROJECTS, 1-16
Credits
Graded P/N.
This course is repeatable for 16 credits.

MTH 607, SEMINAR, 1-16 Credits
This course is repeatable for 99 credits.

MTH 611, COMPLEX ANALYSIS, 3 Credits
Basic theory of analytic functions of a complex variable, including
Cauchy's theorem, residue theorem, analytic continuation, conformal
mappings, entire, and meromorphic functions. All courses used to satisfy
MTH prerequisites must be completed with C or better.
Recommended: MTH 411 or MTH 511

MTH 612, COMPLEX ANALYSIS, 3 Credits
Basic theory of analytic functions of a complex variable, including
Cauchy's theorem, residue theorem, analytic continuation, conformal
mappings, entire, and meromorphic functions. All courses used to satisfy
MTH prerequisites must be completed with C or better.
Recommended: MTH 611

MTH 614, FUNCTIONAL ANALYSIS, 3
Credits
Topological vector spaces, generalized functions, operator theory.
Normally offered alternate years. All courses used to satisfy MTH
prerequisites must be completed with C or better.
Recommended: MTH 513

MTH 619, TOPICS IN ANALYSIS, 1-12
Credits
This course is repeatable for 12 credits.

MTH 621, PARTIAL DIFFERENTIAL
EQUATIONS, 3 Credits
Partial differential equations of physics, including those of potential
theory, wave propagation, and heat flow, treated by classical means,
generalized functions and variational principles. Square summable
function methods and integral equations. This course is the first in a
year-long sequence of MTH 621, MTH 622, MTH 623. All courses used to
satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 6 credits.
Recommended: 6 credits of senior-level analysis

MTH 622, PARTIAL DIFFERENTIAL
EQUATIONS, 3 Credits
Partial differential equations of physics, including those of potential
theory, wave propagation, and heat flow, treated by classical means,
generalized functions and variational principles. Square summable
function methods and integral equations. This course is the first in a
year-long sequence of MTH 621, MTH 622, MTH 623. All courses used to
satisfy MTH prerequisites must be completed with C or better.
Prerequisite: MTH 621 with C or better
This course is repeatable for 6 credits.
MTH 623, PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Partial differential equations of physics, including those of potential theory, wave propagation, and heat flow, treated by classical means, generalized functions and variational principles. Square summable function methods and integral equations. This course is the third one in a year-long sequence. All courses used to satisfy MTH prerequisites must be completed with C or better.
Prerequisite: MTH 621 with C or better and MTH 622 [C]
This course is repeatable for 6 credits.

MTH 627, ADVANCED PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Advanced theory including existence proofs and distributional approach. Normally offered fall term in odd years. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 6 credits.
Recommended: MTH 413 or MTH 513

MTH 628, ADVANCED PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Advanced theory including existence proofs and distributional approach. Normally offered winter term in even years. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 6 credits.
Recommended: MTH 627

MTH 634, ALGEBRAIC TOPOLOGY, 3 Credits
Simplicial and singular homology, products, and cohomology; applications to fixed-point and separation theorems. Topics selected from homotopy, manifold and obstruction theory. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 532

MTH 635, ALGEBRAIC TOPOLOGY, 3 Credits
Simplicial and singular homology, products, and cohomology; applications to fixed-point and separation theorems. Topics selected from homotopy, manifold and obstruction theory. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 532 and MTH 634

MTH 636, ALGEBRAIC TOPOLOGY, 3 Credits
Simplicial and singular homology, products, and cohomology; applications to fixed-point and separation theorems. Topics selected from homotopy, manifold and obstruction theory. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 532 and MTH 635

MTH 644, ABSTRACT ALGEBRA I, 3 Credits
Group theory, rings and fields, Galois theory. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 443 or MTH 543

MTH 645, ABSTRACT ALGEBRA II, 3 Credits
Group theory, rings and fields, Galois theory. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 644

MTH 649, TOPICS IN ALGEBRA AND NUMBER THEORY, 3 Credits
This course is repeatable for 27 credits.

MTH 654, NUMERICAL ANALYSIS, 3 Credits
Advanced topics in numerical analysis, such as finite volume methods and finite element methods for partial differential equations, numerical methods for inverse problems, and image processing. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 12 credits.
Recommended: Familiarity with numerical methods

MTH 655, NUMERICAL ANALYSIS, 3 Credits
Advanced topics in numerical analysis, such as finite volume methods and finite element methods for partial differential equations, numerical methods for inverse problems, and image processing. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 12 credits.
Recommended: Familiarity with numerical methods

MTH 656, NUMERICAL ANALYSIS, 3 Credits
Advanced topics in numerical analysis, such as finite volume methods and finite element methods for partial differential equations, numerical methods for inverse problems, and image processing. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 12 credits.
Recommended: Familiarity with numerical methods

MTH 657, TOPICS IN APPLIED MATHEMATICS, 1-12 Credits
Previous topics have included turbulence, financial mathematics and probability methods in partial differential equations.
This course is repeatable for 12 credits.

MTH 658, TOPICS IN MATHEMATICAL MODELING, 1-12 Credits
Mathematical treatment of topics of current interest in the physical and biological sciences and technology. May be repeated for credit when topic varies.
This course is repeatable for 12 credits.
MTH 659, TOPICS IN NUMERICAL ANALYSIS, 1-12 Credits
This course is repeatable for 12 credits.

MTH 664, PROBABILITY THEORY, 3 Credits
General theory of probability measures and random variables, including weak convergence, characteristic functions, central limit theory, conditional expectations, martingales. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 411 or MTH 511

MTH 665, PROBABILITY THEORY, 3 Credits
General theory of probability measures and random variables, including weak convergence, characteristic functions, the central limit theorem, and the Brownian motion process. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 664

MTH 669, TOPICS IN STOCHASTIC PROCESSES, 1-12 Credits
Previous topics have included Markov processes, martingales, branching processes, and stochastic differential equations.
This course is repeatable for 12 credits.

MTH 674, DIFFERENTIAL GEOMETRY OF MANIFOLDS, 3 Credits
Differentiable manifolds, tangent bundles, vector fields and flows, submanifolds, Riemannian metrics, differential forms, integration on manifolds. Selected topics such as foliations, Lie groups, and de Rham cohomology. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 341 and (MTH 411 or MTH 511)

MTH 675, DIFFERENTIAL GEOMETRY OF MANIFOLDS, 3 Credits
Differentiable manifolds, connections in linear bundles, Riemannian manifolds and submanifolds. Selected topics such as variational theory of geodesics, harmonic forms, and characteristic classes. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 674

MTH 676, TOPICS IN TOPOLOGY, 3 Credits
This course is repeatable for 27 credits.

MTH 679, TOPICS IN GEOMETRY, 1-12 Credits
This course is repeatable for 12 credits.

MTH 682, TEACHING AND LEARNING PROBABILITY AND STATISTICS, 3 Credits
Experimental, activity-based approaches to introductory probability and statistics are explored. Topics include computer simulations, exploratory data analysis, misuses of statistics, and misconceptions of probability. All courses used to satisfy MTH prerequisites must be completed with C or better.

MTH 684, COMPUTERS AND MATHEMATICS, 3 Credits
A variety of mathematical problems are investigated with a laboratory approach using microcomputers and a wide variety of software. Problems may be taken from number theory, calculus, geometry, probability, and elementary numerical analysis. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: Ability to program in either BASIC or PASCAL

MTH 685, ADVANCED PROBLEM SOLVING, 3 Credits
Mathematical problem solving using the heuristic approach of George Polya. Problems may be taken from a variety of areas, including number theory, calculus, geometry, probability, abstract and linear algebra. All courses used to satisfy MTH prerequisites must be completed with C or better.

MTH 689, TOPICS IN MATHEMATICS EDUCATION, 1-12 Credits
Topics may vary.
This course is repeatable for 12 credits.

MTH 699, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.

Physics (PH)

PH 104, *DESCRIPTIVE ASTRONOMY, 4 Credits
Historical and cultural context of discoveries concerning planets and stars and their motions. Topics include the solar system, the constellations, birth and death of stars, pulsars and black holes. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. Lec/lab. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Equivalent to: PH 104H

PH 104H, *DESCRIPTIVE ASTRONOMY, 4 Credits
Historical and cultural context of discoveries concerning planets and stars and their motions. Topics include the solar system, the constellations, birth and death of stars, pulsars and black holes. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. Lec/lab. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science; HNRS – Honors Course Designator
Equivalent to: PH 104
PH 106, *PERSPECTIVES IN PHYSICS, 4 Credits
A descriptive and non-mathematical study of the development of physical concepts and their historical and philosophical context. The emphasis is on the origin, meaning, significance, and limitations of these concepts and their role in the evolution of current understanding of the universe. Concepts to be covered include Copernican astronomy, Newtonian mechanics, energy, electricity and magnetism, relativity, and quantum theory. Intended primarily for non-science students. Lec/lab. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science

PH 107, *DESCRIPTIVE ASTRONOMY: STARS AND THE UNIVERSE, 4 Credits
Examines the structure and lifecycle of the Sun and other stars, and how stars evolve to form white dwarfs, neutron stars, and black holes. Explores galaxies and cosmology, as well as the roles of dark matter and dark energy. Reviews and integrates the basic physics concepts and mathematics required to understand how we have learned what we know about the Universe. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science

PH 111, *INQUIRING INTO PHYSICAL PHENOMENA, 4 Credits
Development of conceptual understandings through investigation of everyday phenomena. Emphasis is on questioning, predicting, exploring, observing, discussing, and writing in physical science contexts. Students document their initial thinking, record their evolving understandings, and write reflections upon how their thinking changed and what fostered their learning. Lec/lab. (Baccalaureate Core Course)
Attributes: CPPS – Core, Pers, Physical Science

PH 198, FIRST-YEAR ORIENTATION, 1 Credit
Introduction to the Physics Department including educational, research, and career opportunities. Recommended for all freshman and transfer physics majors, but open to all students interested in learning about opportunities in Physics.

PH 199, SPECIAL STUDIES, 1-16 Credits
One-credit sections are graded pass/no pass. This course is repeatable for 99 credits.

PH 201, *GENERAL PHYSICS, 5 Credits
Introductory survey course covering a broad spectrum of classical and modern physics with applications. Topics include dynamics, vibrations and waves, electricity and magnetism, optics, and modern physics. Laboratory and recitation sections accompany the lectures. Mathematical preparation should include college algebra and trigonometry. Lec/lab/rec. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Equivalent to: PH 202H
Recommended: MTH 111 and MTH 112
Available via Ecampus

PH 202, *GENERAL PHYSICS, 5 Credits
Introductory survey course covering broad spectrum of classical and modern physics with applications. Topics include dynamics, vibrations and waves, electricity and magnetism, optics, and modern physics. Laboratory and recitation sections accompany the lectures. Mathematical preparation should include college algebra and trigonometry. Lec/lab/rec. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Equivalent to: PH 202H
Recommended: MTH 111 and MTH 112 and PH 201
Available via Ecampus

PH 203, *GENERAL PHYSICS, 5 Credits
Introductory survey course covering broad spectrum of classical and modern physics with applications. Topics include dynamics, vibrations and waves, electricity and magnetism, optics, and modern physics. Laboratory and recitation sections accompany the lectures. Mathematical preparation should include college algebra and trigonometry. Lec/lab/rec. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Equivalent to: PH 203H
Recommended: MTH 111 and MTH 112 and PH 202
Available via Ecampus

PH 205, *SOLAR SYSTEM ASTRONOMY, 4 Credits
History, laws, and tools of astronomy. Composition, motion, and origin of the sun, planets, moons, asteroids, and comets. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. The courses in the astronomy sequence (PH 205, PH 206, PH 207) can be taken in any order. Lec/lab. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Available via Ecampus

PH 206, *STARS AND STELLAR EVOLUTION, 4 Credits
Properties of stars; star formation, evolution, and death; supernovae, pulsars, and black holes. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. The courses in the astronomy sequence (PH 205, PH 206, PH 207) can be taken in any order. Lec/lab. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Available via Ecampus

PH 207, *GALAXIES, COSMOLOGY, LIFE IN THE UNIVERSE, 4 Credits
Nature and content of galaxies, properties of quasars, and the cosmic background radiation. Emphasis on the Big-Bang model and its features. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. The courses in the astronomy sequence (PH 205, PH 206, PH 207) can be taken in any order. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Available via Ecampus
PH 211, *GENERAL PHYSICS WITH CALCULUS, 4 Credits
A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab/rec. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Equivalent to: PH 211H
Recommended: MTH 251 and concurrent enrollment in MTH 252 and a PH 221 recitation section

PH 211H, *GENERAL PHYSICS WITH CALCULUS, 4 Credits
A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab/rec. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science; HNRS – Honors Course Designator
Equivalent to: PH 211
Recommended: MTH 251 and concurrent enrollment in MTH 252 and a PH 221 recitation section

PH 212, *GENERAL PHYSICS WITH CALCULUS, 4 Credits
A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Prerequisite: PH 211 with D- or better or PH 211H with D- or better
Equivalent to: PH 212H
Recommended: MTH 252 and concurrent enrollment in PH 222 and MTH 254

PH 212H, *GENERAL PHYSICS WITH CALCULUS, 4 Credits
A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science; HNRS – Honors Course Designator
Prerequisite: PH 211 with D- or better or PH 211H with D- or better
Equivalent to: PH 212
Recommended: MTH 252 and concurrent enrollment in PH 222 and MTH 254

PH 213, *GENERAL PHYSICS WITH CALCULUS, 4 Credits
A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab/rec. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science
Equivalent to: PH 213H
Recommended: (MTH 254 or MTH 254H) and (PH 212 or PH 212H). Concurrent enrollment in a recitation section is strongly recommended

PH 213H, *GENERAL PHYSICS WITH CALCULUS, 4 Credits
A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab/rec. (Bacc Core Course)
Attributes: CPPS – Core, Pers, Physical Science; HNRS – Honors Course Designator
Prerequisite: (MTH 254 or MTH 254H) and (PH 212 or PH 212H). Concurrent enrollment in a recitation section is strongly recommended

PH 221, RECITATION FOR PHYSICS 211, 1 Credit
One-hour weekly session for the development of problem-solving skills in calculus-based general physics.
Prerequisite: PH 211 (may be taken concurrently) with D- or better or PH 211H (may be taken concurrently) with D- or better
Equivalent to: PH 221H

PH 221H, RECITATION FOR PHYSICS 211, 1 Credit
One-hour weekly session for the development of problem-solving skills in calculus-based general physics.
Attributes: HNRS – Honors Course Designator
Prerequisite: PH 211 (may be taken concurrently) with D- or better or PH 211H (may be taken concurrently) with D- or better
Equivalent to: PH 221

PH 222, RECITATION FOR PHYSICS 212, 1 Credit
One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Graded P/N.
Prerequisite: PH 212 (may be taken concurrently) with D- or better or PH 212H (may be taken concurrently) with D- or better
Equivalent to: PH 222H
PH 222H, RECITATION FOR PHYSICS 212, 1 Credit
One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Lec/rec. Graded P/N.
Attributes: HNRS – Honors Course Designator
Prerequisite: PH 212 (may be taken concurrently) with D- or better or PH 212H (may be taken concurrently) with D- or better
Equivalent to: PH 222
Recommended: Concurrent enrollment in PH 212 or PH 212H

PH 223, RECITATION FOR PHYSICS 213, 1 Credit
One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Lec/rec. Graded P/N.
Prerequisite: PH 213 (may be taken concurrently) with D- or better or PH 213H (may be taken concurrently) with D- or better
Equivalent to: PH 223H

PH 223H, RECITATION FOR PHYSICS 213, 1 Credit
One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Lec/rec. Graded P/N.
Attributes: HNRS – Honors Course Designator
Prerequisite: PH 213 (may be taken concurrently) with D- or better or PH 213H (may be taken concurrently) with D- or better
Equivalent to: PH 223
Recommended: Concurrent enrollment in PH 213

PH 265, SCIENTIFIC COMPUTING, 3 Credits
Basic computational tools and techniques for courses in science and engineering. Project approach to problem solving using symbolic and compiled languages with visualization. Basic computer literacy assumed.
Equivalent to: CS 265
Recommended: Concurrent enrollment in MTH 251

PH 299, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.

PH 313, *ENERGY ALTERNATIVES, 3 Credits
Exploration of the challenges and opportunities posed by dwindling resources; physical and technological basis of our current energy alternatives; new or controversial technologies such as nuclear or solar power; overview of resource availability, patterns of energy consumption, and current governmental policies. (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society; HNRS – Honors Course Designator
Equivalent to: PH 313
Recommended: Upper-division standing and 12 credits of introductory science

PH 313H, *ENERGY ALTERNATIVES, 3 Credits
Exploration of the challenges and opportunities posed by dwindling resources; physical and technological basis of our current energy alternatives; new or controversial technologies such as nuclear or solar power; overview of resource availability, patterns of energy consumption, and current governmental policies. (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society; HNRS – Honors Course Designator
Equivalent to: PH 313
Recommended: Upper-division standing and 12 credits of introductory science

PH 315, PHYSICS OF CONTEMPORARY CHALLENGES, 3 Credits
An introduction to thermal and quantum physics in the context of contemporary challenges faced by our society, such as power generation, energy efficiency, and global warming.
Recommended: PH 211

PH 317, ^EXPERIMENTAL PHYSICS, 3 Credits
Conducting experiments, understanding equipment, modeling physical phenomena, analyzing and presenting data, sources of variation and uncertainty. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (PH 213 with C- or better or PH 213H with C- or better) and PH 315 [C-] and PH 335 [C-]
Equivalent to: PH 317X

PH 331, *SOUND, HEARING, AND MUSIC, 3 Credits
Basic course in the physics, technology, and societal implications of sound. Intended for students in nontechnical majors. Topics include wave motion, hearing and the perception of sound, noise pollution, music and musical instruments, architectural acoustics, and sound recording and reproduction. (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Recommended: Upper-division standing and one year of university science

PH 332, *LIGHT, VISION, AND COLOR, 3 Credits
Basic physics of light, optical instruments (lenses, telescopes, microscopes), the eye and visual perception, colors, photography, environmental lighting, lasers and holography. For nontechnical majors. (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Recommended: Upper-division standing and one year of university science

PH 335, TECHNIQUES OF THEORETICAL MECHANICS, 3 Credits
Newtonian, Lagrangian, and Hamiltonian classical mechanics. Special relativity with relativistic mechanics.
Recommended: PH 212 and MTH 254
PH 365, COMPUTATIONAL PHYSICS LAB, 1 Credit
A project-driven laboratory experience in computational physics. Includes the use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered will coordinate with the Paradigms in Physics course sequence.
Prerequisite: PH 213 with C- or better or PH 213H with C- or better
Equivalent to: PH 365X
Recommended: Concurrent enrollment in Paradigms

PH 366, COMPUTATIONAL PHYSICS LAB, 1 Credit
A project-driven laboratory experience in computational physics. Includes the use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered will coordinate with the Paradigms in Physics course sequence.
Prerequisite: PH 213 with C- or better or PH 213H with C- or better
Recommended: Concurrent enrollment in Paradigms

PH 367, COMPUTATIONAL PHYSICS LAB, 1 Credit
A project-driven laboratory experience in computational physics. Includes the use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered will coordinate with the Paradigms in Physics course sequence.
Prerequisite: PH 213 with C- or better or PH 213H with C- or better
Recommended: Concurrent enrollment in Paradigms

PH 399, SPECIAL TOPICS, 1-16 Credits
Equivalent to: PH 399H
This course is repeatable for 16 credits.

PH 399H, SPECIAL TOPICS, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: PH 399
This course is repeatable for 16 credits.

PH 401, RESEARCH, 1-16 Credits
A research project under the supervision of a faculty member, whose approval must be arranged by the student in advance of registration. This course is repeatable for 16 credits.

PH 403, ^THESIS, 1-16 Credits
A research project leading to a thesis under the supervision of a faculty member, whose approval must be arranged by the student in advance of registration. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
This course is repeatable for 16 credits.

PH 405, READING AND CONFERENCE, 1-16 Credits
An independent study project under the supervision of a faculty member, whose approval must be arranged by the student in advance of registration.
This course is repeatable for 16 credits.
PH 425, PARADIGMS IN PHYSICS: QUANTUM FUNDAMENTALS, 3 Credits
Introduction to quantum mechanics through Stern-Gerlach spin measurements. Probability, eigenvalues, operators, measurement, state reduction, Dirac notation, matrix mechanics, time evolution. Quantum behavior of a one-dimensional well.
Recommended: PH 213 and concurrent enrollment in MTH 341

PH 426, PARADIGMS IN PHYSICS: CENTRAL FORCES, 3 Credits
Gravitational and electrostatic forces; angular momentum and spherical harmonics, separation of variables in classical and quantum mechanics, hydrogen atom.
Recommended: PH 213 and PH 422 and PH 425 and concurrent enrollment in PH 335

PH 427, PARADIGMS IN PHYSICS: PERIODIC SYSTEMS, 3 Credits
Quantum waves in position and momentum space; Bloch waves in one-dimensional periodic systems, and the reciprocal lattice; coupled harmonic oscillators; phonons.
Recommended: PH 424 and PH 425 and concurrent enrollment in PH 315

PH 431, CAPSTONES IN PHYSICS: ELECTROMAGNETISM, 3 Credits
Static electric and magnetic fields in matter, electrodynamics, Maxwell equations, electromagnetic waves, wave guides, dipole radiation.
Recommended: (PH 424 or 524) and (PH 426 or PH 526)

PH 441, CAPSTONES IN PHYSICS: THERMAL AND STATISTICAL PHYSICS, 3 Credits
Entropy and quantum mechanics; canonical Gibbs probability; ideal gas; thermal radiation; Einstein and Debye lattices; grand canonical Gibbs probability; ideal Fermi and Bose gases; chemical reactions and phase transformations.
Recommended: (PH 423 or PH 523) and (PH 451 or PH 551)

PH 451, CAPSTONES IN PHYSICS: QUANTUM MECHANICS, 3 Credits
Wave mechanics, Schrödinger equation, operators, harmonic oscillator, identical particles, atomic fine structure, approximation methods and applications.
Recommended: (PH 424 or PH 524) and (PH 425 or PH 525) and (PH 426 or PH 526)

PH 455, ASTROPHYSICS, 3 Credits
Physics of stars and the cosmos.
Recommended: PH 213; PH 315 or equivalent junior-level background in modern physics and thermodynamics.

PH 464, SCIENTIFIC COMPUTING II, 3 Credits
Mathematical, numerical, and conceptual elements forming foundations of scientific computing: computer hardware, algorithms, precision, efficiency, verification, numerical analysis, algorithm scaling, profiling, and tuning. Lec/lab.
Equivalent to: PH 365

PH 465, COMPUTATIONAL PHYSICS, 3 Credits
The use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered include models and applications ranging from classical mechanics and electromagnetism to modern solid state and particle physics.
Recommended: PH 464 or PH 564

PH 481, PHYSICAL OPTICS, 4 Credits
Wave propagation, polarization, interference, diffraction, and selected topics in modern optics.
Recommended: PH 431 or PH 531

PH 482, OPTICAL ELECTRONIC SYSTEMS, 4 Credits
Photodetectors, laser theory, and laser systems. Lec/lab. CROSSLISTED as ECE 482/PH 482 and ECE 582/PH 582.
Equivalent to: ECE 482
Recommended: ECE 391 or (PH 481 or PH 581)

PH 483, GUIDED WAVE OPTICS, 4 Credits
Optical fibers, fiber mode structure and polarization effects, fiber interferometry, fiber sensors, optical communication systems. Lec/lab. CROSSLISTED as ECE 483/PH 483 and ECE 583/PH 583.
Equivalent to: ECE 483
Recommended: Completion or concurrent enrollment in ECE 391 or PH 481

PH 495, INTRODUCTION TO PARTICLE AND NUCLEAR PHYSICS, 3 Credits
Elementary particles and forces, nuclear structure and reactions.
Recommended: PH 451 or PH 551

PH 499, SPECIAL TOPICS, 1-16 Credits
Topics vary from year to year. May be repeated for credit. Not offered every year.
This course is repeatable for 16 credits.

PH 501, RESEARCH, 1-16 Credits
Graded P/N.
This course is repeatable for 16 credits.

PH 503, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

PH 505, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.
PH 507, SEMINAR, 1-16 Credits
Section 1: Departmental Colloquium. Section 3: Nuclear and Particle Physics. Section 5: Atomic, Molecular, and Optical Physics. Section 7: Solid State Physics. Section 9: Computational Physics. One-credit options are graded P/N.
This course is repeatable for 16 credits.

PH 510, INTERNSHIP, 1-16 Credits
This course is repeatable for 16 credits.

PH 511, ELECTRONICS, 3 Credits
Covers how to build and analyze basic circuits. Topics include passive dc and ac circuits including filters, complex impedance, Fourier analysis, operational amplifiers, semiconductor diodes, and transistors.
Recommended: PH 213

PH 515, COMPUTER INTERFACING AND INSTRUMENTATION, 3 Credits
Applications of computers as scientific instruments, with emphasis on hardware and instrumentation, online data acquisition, and computer control of experiments.

PH 531, CAPSTONES IN PHYSICS: ELECTROMAGNETISM, 3 Credits
Static electric and magnetic fields in matter, electrodynamics, Maxwell equations, electromagnetic waves, wave guides, dipole radiation.
Recommended: (PH 424 or PH 524) and (PH 426 or PH 526)

PH 541, CAPSTONES IN PHYSICS: THERMAL AND STATISTICAL PHYSICS, 3 Credits
Entropy and quantum mechanics; canonical Gibbs probability; ideal gas; thermal radiation; Einstein and Debye lattices; grand canonical Gibbs probability; ideal Fermi and Bose gases; chemical reactions and phase transformations.
Recommended: (PH 423 or PH 523) and (PH 451 or PH 551)

PH 551, CAPSTONES IN PHYSICS: QUANTUM MECHANICS, 3 Credits
Wave mechanics, Schroedinger equation, operators, harmonic oscillator, identical particles, atomic fine structure, approximation methods and applications.
Recommended: (PH 424 or PH 524) and (PH 425 or PH 525) and (PH 426 or PH 526)

PH 555, ASTROPHYSICS, 3 Credits
Physics of stars and the cosmos.
Recommended: PH 213; PH 315 or equivalent junior-level background in modern physics and thermodynamics.

PH 562, MATHEMATICAL PHYSICS, 3 Credits
Fundamental mathematical techniques needed for graduate students in physics. Topics include vector spaces and operators; fourier series, integrals, and transforms; partial differential equations; special functions, distributions, and delta functions; Green's functions; complex analysis.

PH 564, SCIENTIFIC COMPUTING II, 3 Credits
Mathematical, numerical, and conceptual elements forming foundations of scientific computing: computer hardware, algorithms, precision, efficiency, verification, numerical analysis, algorithm scaling, profiling, and tuning. Lec/lab.
Equivalent to: PH 365

PH 575, INTRODUCTION TO SOLID STATE PHYSICS, 3 Credits
Introduction to condensed matter physics for majors in physics, chemistry, and engineering. Topics include band structure, free electron behavior, optical properties, magnetism, and lattice excitations.
Recommended: (PH 451 or PH 551) and concurrent enrollment in PH 427 or PH 527

PH 581, PHYSICAL OPTICS, 4 Credits
Wave propagation, polarization, interference, diffraction, and selected topics in modern optics.
Recommended: PH 431 or PH 531

PH 582, OPTICAL ELECTRONIC SYSTEMS, 4 Credits
Photodetectors, laser theory, and laser systems. Lec/lab. CROSSLISTED as ECE 482/PH 482 and ECE 582/PH 582.
Equivalent to: ECE 582
Recommended: PH 481 or PH 581

PH 583, GUIDED WAVE OPTICS, 4 Credits
Optical fibers, fiber mode structure and polarization effects, fiber interferometry, fiber sensors, optical communication systems. Lec/lab. CROSSLISTED as ECE 483/PH 483 and ECE 583/PH 583.
Equivalent to: ECE 583
Recommended: Completion or concurrent enrollment in ECE 391 or PH 481/581

PH 585, ATOMIC, MOLECULAR, AND OPTICAL PHYSICS, 3 Credits
Atomic and molecular structure, interaction with electromagnetic fields, atomic and molecular spectra, spectroscopic techniques, laser theory, nonlinear optics.
Recommended: (PH 431 or PH 531) or (PH 451 or PH 551)

PH 591, BIOLOGICAL PHYSICS, 3 Credits
Basic physics principles applied to the kinetics and dynamics of molecular and cellular processes. Ion channels, two-state systems, dynamics of molecular motors, cell signalling, and multicellular phenomena.
Recommended: PH 320, PH 421, PH 422 and PH 423 or junior-level background in classical mechanics, electromagnetism, and thermodynamics

PH 595, INTRODUCTION TO PARTICLE AND NUCLEAR PHYSICS, 3 Credits
Elementary particles and forces, nuclear structure and reactions.
Recommended: PH 451 or PH 551
PH 599, SPECIAL TOPICS, 1-16 Credits
(See PH 499 for description.)
This course is repeatable for 16 credits.

PH 601, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

PH 603, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

PH 605, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

PH 607, SEMINAR, 1-16 Credits
Section 1: Departmental Colloquium. Section 3: Nuclear and Particle Physics. Section 5: Atomic, Molecular, and Optical Physics. Section 7: Solid State Physics. Section 9: Computational Physics. One-credit options are graded P/N.
This course is repeatable for 16 credits.

PH 609, PRACTICUM IN TEACHING, 1-6 Credits
This course is repeatable for 6 credits.

PH 621, DYNAMICS OF SINGLE- AND MULTI-PARTICLE SYSTEMS, 3 Credits
Introduction to theory of non-linear systems. Chaos in Hamiltonian and dissipative systems. Lyapunov exponents, fractal geometries.
Recommended: PH 435 or PH 535

PH 631, ELECTROMAGNETIC THEORY, 3 Credits
Electrostatics; multipole expansion; magnetostatics; radiation fields; dynamics of relativistic particles and electromagnetic fields.
Recommended: PH 431 or PH 531

PH 632, ELECTROMAGNETIC THEORY, 3 Credits
Electrostatics; multipole expansion; magnetostatics; radiation fields; dynamics of relativistic particles and electromagnetic fields.
Recommended: PH 631 and (PH 431 or PH 531)

PH 633, ELECTROMAGNETIC THEORY, 3 Credits
Electrostatics; multipole expansion; magnetostatics; radiation fields; dynamics of relativistic particles and electromagnetic fields.
Recommended: PH 632 and (PH 431 or PH 531)

PH 641, STATISTICAL THERMOPHYSICS, 3 Credits
Macroscopic thermodynamics and kinetic theory. Classical and quantal statistical ensembles; partition functions. Applications to atoms and molecules, clustering, solids, radiation.
Recommended: PH 435 or PH 535

PH 642, STATISTICAL THERMOPHYSICS, 3 Credits
Macroscopic thermodynamics and kinetic theory. Classical and quantal statistical ensembles; partition functions. Applications to atoms and molecules, clustering, solids, radiation.
Recommended: PH 641

PH 651, QUANTUM MECHANICS, 3 Credits
Basic principles of nonrelativistic quantum theory and applications.
Schroedinger theory, quantum theory of angular momentum, matrix mechanics, perturbation theory, identical particles, scattering.
Recommended: (PH 435 or PH 535) and (PH 451 or PH 551)

PH 652, QUANTUM MECHANICS, 3 Credits
Basic principles of nonrelativistic quantum theory and applications.
Schroedinger theory, quantum theory of angular momentum, matrix mechanics, perturbation theory, identical particles, scattering.
Recommended: (PH 435 or PH 535) and (PH 451 or PH 551) and PH 651

PH 653, QUANTUM MECHANICS, 3 Credits
Basic principles of nonrelativistic quantum theory and applications.
Schroedinger theory, quantum theory of angular momentum, matrix mechanics, perturbation theory, identical particles, scattering.
Recommended: (PH 435 or PH 535) and (PH 451 or PH 551) and PH 652

PH 654, ADVANCED QUANTUM THEORY, 3 Credits
Scattering theory, second quantization and many body theory, relativistic quantum mechanics, quantization of fields, quantum electrodynamics, and elementary particles.
Recommended: PH 653

PH 655X, ADVANCED QUANTUM THEORY, 3 Credits
Covers scattering theory, second quantization and many body theory, relativistic quantum mechanics, quantization of fields, quantum electrodynamics, and elementary particles.
Prerequisite: PH 654 with C- or better

PH 671, SOLID STATE PHYSICS, ELECTRON TRANSPORT, 3 Credits
Fundamentals of solid state physics, Boltzmann transport, phonon and defect scattering, quantum transport, transport in magnetic field, localization, Mott-insulator transition, electron tunneling, superconductivity. Not offered every year.
Recommended: Basic knowledge of electromagnetism and quantum mechanics

PH 672, SOLID STATE PHYSICS, THEORY, 3 Credits
The many-body problem, density functional theory, excited states, properties, BCS theory of superconductivity. Not offered every year.
Prerequisite: PH 575 with D- or better and PH 654 [D-]
Recommended: Basic knowledge of electromagnetism and quantum mechanics
**PH 673, SOLID STATE PHYSICS, NANOSCIENCE AND NANOTECHNOLOGY, 3 Credits**

Introduction to nanoscience and nanotechnology; semiconductor quantum wells, wires, and dots; bulk metals vs nanoparticles; molecular ensembles vs single molecules; fabrication of nanoparticles and nanostructured materials; scanning probe microscopy; advanced optical imaging and manipulation. Not offered every year.

**Recommended:** Basic knowledge of electromagnetism and quantum mechanics

**PH 674, SOLID STATE PHYSICS, MAGNETISM, 2 Credits**

Magnetism of atoms; interaction between magnetic atoms, magnetic ordering in crystalline solids; excitations in magnetic solids; temperature dependent phenomena in magnetic solids; magnetism of metals, alloys, insulators and semiconductors; topics of considerable interest in contemporary research.

**Recommended:** Basic knowledge of electromagnetism and quantum mechanics

**PH 681, ATOMIC, MOLECULAR AND OPTICAL PHYSICS, MODERN OPTICS, 3 Credits**

Maxwell’s equations in matter; refraction, phase and group indices; material and geometry dispersion; effective-medium regime. Not offered every year.

**Recommended:** Basic knowledge of electromagnetism and quantum mechanics

**PH 682, ATOMIC, MOLECULAR, OPTICAL PHYSICS, SEMICONDUCTOR OPTICS, 3 Credits**

Linear response theory; polarization effects; interband excitations and emissions; low dimensional systems; excitons; phonons; semiconductor lasers; photovoltaics. Not offered every year.

**Recommended:** Basic knowledge of electromagnetism and quantum mechanics

**PH 683, ATOMIC, MOLECULAR AND OPTICAL PHYSICS, NONLINEAR OPTICS, 3 Credits**

Coherent nonlinear electromagnetic phenomena; harmonic generation and parametric mixing; quantum mechanical description of multi-photon interactions; incoherent multi-photon interactions; coherent nonlinear optical phenomena and spectroscopies. Not offered every year.

**Recommended:** Basic knowledge of electromagnetism and quantum mechanics

**PH 684, ATOMIC, MOLECULAR AND OPTICAL PHYSICS, ULTRAFAST OPTICS, 2 Credits**

Introduction of ultrafast optical science; short pulse propagation in linear media; pulse stretching and compressing; Q-switching and mode-locking; characterization of femtosecond lasers; coherent optical effects. Offered in alternate years.

**Recommended:** Basic knowledge of electromagnetism and quantum mechanics

**PH 699, SPECIAL TOPICS: BIOLOGICAL PHYSICS, 3 Credits**

Topics vary from year to year. Not offered every year.

*This course is repeatable for 9 credits.*

**Science (SCI)**

**SCI 470, FOUNDATIONS OF INNOVATION, 2 Credits**

Learn the basic language and the initial skill set needed to address how scientific ideas and research results become innovations – solutions that address societal and market needs. Acquire the skills to become innovators and to create value for all types of academic, small-company, industrial, governmental, and non-profit research and development organizations. Students work in areas aligned with their scientific interests either individually or in a team. CROSSTOALED as CH 470/SCI 470 and CH 570/SCI 570.

*Equivalent to:* CH 470

**Recommended:** Science and engineering majors

**SCI 472, RESEARCH TO INNOVATION, 2 Credits**

Produce a first-pass product-market gap analysis on one example application of a science technology platform in a given market. Define a platform in collaboration with research faculty or from work completed in CH 470/SCI 470 or CH 570/SCI 570. Assess the opportunity – if any – that a product might have for application in a chosen market before planning and conducting scientific research. CROSSTOALED as CH 472/SCI 472 and CH 572/SCI 572.

**Prerequisite:** SCI 470 with C or better or CH 470 with C or better

*Equivalent to:* CH 472

**Recommended:** Science and engineering majors

**SCI 474, INNOVATION TO IMPACT, 2 Credits**

Build on skills gained in CH 472/SCI 472 or CH 572/SCI 572 to conduct and refine a first pass product-market gap analysis on one example application of a technology platform for a market segment selected from a defined technology platform. Investigate and determine the opportunity – if any – that a product might have in a chosen market before proposing and executing a research plan. CROSSTOALED as CH 474/SCI 474 and CH 574/SCI 574.

**Prerequisite:** SCI 472 with C or better or CH 472 with C or better

*Equivalent to:* CH 474

**Recommended:** Undergraduate juniors and seniors in STEM majors
SCI 570, FOUNDATIONS OF INNOVATION, 2 Credits
Learn the basic language and the initial skill set needed to address how scientific ideas and research results become innovations – solutions that address societal and market needs. Acquire the skills to become innovators and to create value for all types of academic, small-company, industrial, governmental, and non-profit research and development organizations. Students work in areas aligned with their scientific interests either individually or in a team. CROSSLISTED as CH 470/SCI 470 and CH 570/SCI 570.
Equivalent to: CH 570
Recommended: Science and engineering majors

SCI 572, RESEARCH TO INNOVATION, 2 Credits
Produce a first-pass product-market gap analysis on one example application of a science technology platform in a given market. Define a platform in collaboration with research faculty or from work completed in CH 470/SCI 470 or CH 570/SCI 570. Assess the opportunity – if any – that a product might have for application in a chosen market before planning and conducting scientific research. CROSSLISTED as CH 472/SCI 472 and CH 572/SCI 572.
Equivalent to: CH 572
Recommended: STEM graduate students

SCI 574, INNOVATION TO IMPACT, 2 Credits
Build on skills gained in CH 472/SCI 472 or CH 572/SCI 572 to conduct and refine a first-pass product-market gap analysis on one example application of a technology platform for a market segment selected from a defined technology platform. Investigate and determine the opportunity – if any – that a product might have in a chosen market before proposing and executing a research plan. CROSSLISTED as CH 474/SCI 474 and CH 574/SCI 574.
Prerequisite: SCI 572 with B or better or CH 572 with B or better
Equivalent to: CH 574
Recommended: Graduate students in STEM

Statistics (ST)
ST 199, SPECIAL TOPICS, 3 Credits
This course can only be taken once unless instructor permission is provided.

ST 201, PRINCIPLES OF STATISTICS, 4 Credits
Study design, descriptive statistics, the use of probability in statistical arguments, sampling, hypothesis tests and confidence intervals for means and proportions. Lec/Rec.
Equivalent to: ST 201H
Recommended: High school algebra
Available via Ecampus

ST 202, PRINCIPLES OF STATISTICS, 4 Credits
Comparisons of means and proportions between two populations (t-tests, chi-square tests, nonparametric tests), simple linear regression, correlation. Lec/Rec.
Prerequisite: ST 201 with D- or better
Equivalent to: ST 209
Available via Ecampus

ST 314, INTRODUCTION TO STATISTICS FOR ENGINEERS, 3 Credits
Probability, common probability distributions, sampling distributions, estimation, hypothesis testing, control charts, regression analysis, experimental design.
Prerequisite: MTH 252 with D- or better or MTH 252H with D- or better
Equivalent to: ST 314H
Available via Ecampus

ST 351, INTRODUCTION TO STATISTICAL METHODS, 4 Credits
Study designs, descriptive statistics, collecting and recording data, probability distributions, sampling distributions for means and proportions, hypothesis testing and confidence intervals for means and proportions in one- and two-sample inference, and chi-square tests. Lec/lab.
Equivalent to: ST 351H
Recommended: High school algebra with statistics
Available via Ecampus

ST 351H, INTRODUCTION TO STATISTICAL METHODS, 4 Credits
Study designs, descriptive statistics, collecting and recording data, probability distributions, sampling distributions for means and proportions, hypothesis testing and confidence intervals for means and proportions in one- and two-sample inference, and chi-square tests. Lec/lab.
Attributes: HNRS – Honors Course Designator
Equivalent to: ST 351
Recommended: High school algebra with statistics

ST 352, INTRODUCTION TO STATISTICAL METHODS, 4 Credits
Randomization tests and other nonparametric tests for one- and two-sample inference, simple and multiple linear regression, correlation, one- and two-way analysis of variance, logistic regression. Lec/lab.
Prerequisite: ST 351 with D- or better or ST 351H with D- or better
Available via Ecampus

ST 405, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

ST 406, PROJECTS, 1-16 Credits
Section 1: Projects, graded P/N. Section 2: Teaching Experience, graded P/N. Section 3: Directed Work, graded P/N.
This course is repeatable for 16 credits.
ST 407, SEMINAR, 1 Credit
Attendance at consulting practicum. Graded P/N.

ST 410, INTERNSHIP, 1-16 Credits
Graded P/N. This course is repeatable for 16 credits.

ST 411, METHODS OF DATA ANALYSIS, 4 Credits
Graphical, parametric and nonparametric methods for comparing two samples; one-way and two-way analysis of variance; simple linear regression. Lec/lab. Recommended: ST 351

ST 412, METHODS OF DATA ANALYSIS, 4 Credits
Multiple linear regression, including model checking, dummy variables, using regression to fit analysis of variance models, analysis of covariance, variable selection methods. Lec/lab. Prerequisite: ST 411 with D- or better Recommended: ST 351

ST 413, METHODS OF DATA ANALYSIS, 4 Credits
Principles of experimental design; randomized block and factorial designs; repeated measures; categorical data analysis, including comparison of proportions, tests of homogeneity and independence in cross-classified frequency tables, Mantel-Haenszel test, logistic regression, log-linear regression. Introduction to multivariate statistics. Lec/lab. Prerequisite: ST 412 with D- or better Recommended: ST 351

ST 415, DESIGN AND ANALYSIS OF PLANNED EXPERIMENTS, 3 Credits
Principles of experimental design; uses, construction and analysis of completely randomized, randomized block and Latin square designs; covariates; factorial treatments, split plotting; random effects and variance components. Prerequisite: ST 352 with D- or better or ST 411 with D- or better or ST 511 with D- or better

ST 421, INTRODUCTION TO MATHEMATICAL STATISTICS, 4 Credits
Probability, random variables, expectation, discrete and continuous distributions, multivariate distributions. Recommended: MTH 253

ST 422, INTRODUCTION TO MATHEMATICAL STATISTICS, 4 Credits
Sampling distributions, Central Limit Theorem, estimation, confidence intervals, properties of estimators, and hypothesis testing. Prerequisite: ST 421 with D- or better Recommended: MTH 253

ST 431, SAMPLING METHODS, 3 Credits
Estimation of means, totals and proportions; sampling designs including simple random, stratified, cluster, systematic, multistage and double sampling; ratio and regression estimators; sources of errors in surveys; capture-recapture methods. Recommended: ST 411 or ST 511

ST 435, QUANTITATIVE ECOLOGY, 3 Credits
Overview of statistical methods that are useful for analyzing ecological data, including spatial pattern analysis, multivariate techniques, logistic regression, Bayesian statistics and computer-intensive methods. Consideration of special topics such as population dynamics, food webs and ecological indicators. Not offered every year. Prerequisite: ST 412 with D- or better or ST 512 with D- or better

ST 439, SURVEY METHODS, 3 Credits
Survey design, data collection and analysis, general methodology. Prerequisite: ST 201 with D- or better or ST 351 with D- or better

ST 441, PROBABILITY, COMPUTING, AND SIMULATION IN STATISTICS, 4 Credits
Review of probability, including univariate distributions and limit theorems. Random-number generation and simulation of statistical distributions. Bootstrap estimates of standard error. Variance reduction techniques. Emphasis on the use of computation in statistics using the MATLAB programming language. Lec/lab. Prerequisite: ST 422 with D- or better or ST 522 with D- or better

ST 443, APPLIED STOCHASTIC MODELS, 3 Credits
Development of stochastic models commonly arising in statistics and operations research, such as Poisson processes, birth-and-death processes, discrete-time and continuous-time Markov chains, renewal and Markov renewal processes. Analysis of stochastic models by simulation and other computational techniques. Prerequisite: ST 421 with D- or better or ST 521 with D- or better Recommended: Experience with a high-level programming language or mathematical computation package

ST 499, SPECIAL TOPICS, 1-4 Credits
May be repeated for credit. This course is repeatable for 8 credits.

ST 501, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

ST 503, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

ST 505, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

ST 506, PROJECTS, 1-16 Credits
Section 1: Projects. Section 2: Teaching Experience. Section 3: Directed Work. This course is repeatable for 16 credits.
ST 507, SEMINAR, 1 Credit
Section 1: Attendance at consulting practicum, 1 credit. Section 3: Research Seminar, 1 credit. Section 4: Computing Facilities, 1 credit. All sections graded P/N.
This course is repeatable for 99 credits.

ST 509, CONSULTING PRACTICUM, 2 Credits
The student provides statistical advice, under faculty guidance, on university-related research projects.
This course is repeatable for 99 credits.
Recommended: ST 507 and ST 553

ST 510, INTERNSHIP, 1-16 Credits
Graded P/N.
This course is repeatable for 16 credits.

ST 511, METHODS OF DATA ANALYSIS, 4 Credits
Graphical, parametric and nonparametric methods for comparing two samples; one-way and two-way analysis of variance; simple linear regression. Lec/lab.
Recommended: ST 351

ST 512, METHODS OF DATA ANALYSIS, 4 Credits
Multiple linear regression, including model checking, dummy variables, using regression to fit analysis of variance models, analysis of covariance, variable selection methods. Lec/lab.
Prerequisite: ST 511 with C or better
Recommended: ST 351

ST 513, METHODS OF DATA ANALYSIS, 4 Credits
Principles of experimental design; randomized block and factorial designs; repeated measures; categorical data analysis, including comparison of proportions, tests of homogeneity and independence in cross-classified frequency tables, Mantel-Haenszel test, logistic regression, log-linear regression. Introduction to multivariate statistics. Lec/lab.
Prerequisite: ST 512 with C or better
Recommended: ST 351

ST 515, DESIGN AND ANALYSIS OF PLANNED EXPERIMENTS, 3 Credits
Principles of experimental design; uses, construction and analysis of completely randomized, randomized block and Latin square designs; covariates; factorial treatments, split plotting; random effects and variance components.
Recommended: ST 352 or (ST 411 or ST 511)
Available via Ecampus

ST 516, FOUNDATIONS OF DATA ANALYTICS, 4 Credits
Foundations of estimation and hypothesis testing; desirable properties of estimators; maximum likelihood; one- and two-sample problems; theoretical results are explored through simulations and analysis using R. Offered via Ecampus only.
Recommended: ST 351
Available via Ecampus

ST 517, DATA ANALYTICS I, 4 Credits
Methods for modeling quantitative data and statistical learning—simple and multiple linear regression; linear mixed effects models; data imputation; prediction and cross-validation; scaling up to large datasets. Simulations and data analysis using R. Offered via Ecampus only.
Prerequisite: ST 516 with C+ or better

ST 518, DATA ANALYTICS II, 4 Credits
Statistical methods and data analysis techniques for count data. Topics include tests for tables of counts, logistic regression, log-linear regression, generalized linear mixed models, and issues for large datasets. Data analysis in R.
Prerequisite: ST 517 with C+ or better
Available via Ecampus

ST 521, INTRODUCTION TO MATHEMATICAL STATISTICS, 4 Credits
Probability, random variables, expectation, discrete and continuous distributions, multivariate distributions.
Recommended: MTH 253

ST 522, INTRODUCTION TO MATHEMATICAL STATISTICS, 4 Credits
Sampling distributions, Central Limit Theorem, estimation, confidence intervals, properties of estimators, and hypothesis testing.
Prerequisite: ST 521 with C or better
Recommended: MTH 253

ST 525, APPLIED SURVIVAL ANALYSIS, 3 Credits
Statistical methods for analyzing survival data or time-to-event data, which may be censored and/or truncated. Specific topics can vary term to term, and could include Kaplan-Meier estimator; K-sample hypothesis tests for survival data; Accelerated failure time model; Cox proportional hazard regression model.
Prerequisite: ST 516 with C or better and ST 517 [C] and ST 518 [C]
Available via Ecampus

ST 531, SAMPLING METHODS, 3 Credits
Estimation of means, totals and proportions; sampling designs including simple random, stratified, cluster, systematic, multistage and double sampling; ratio and regression estimators; sources of errors in surveys; capture-recapture methods.
Recommended: ST 411 or ST 511
**ST 535, QUANTITATIVE ECOLOGY, 3 Credits**
Overview of statistical methods that are useful for analyzing ecological data, including spatial pattern analysis, multivariate techniques, logistic regression, Bayesian statistics and computer-intensive methods.
Consideration of special topics such as population dynamics, food webs and ecological indicators. Not offered every year.
**Recommended:** ST 412 or ST 512

**ST 537, DATA VISUALIZATION, 3 Credits**
Perceptual principles for displaying data; critique and improvement of data visualizations; use of color in visualization; principles of tidy data; strategies for data exploration; select special topics.
**Prerequisite:** ST 512 with C or better or ST 517 with C or better or ST 552 with C or better
**Recommended:** Familiarity with linear regression and using R

**ST 538, MODERN STATISTICAL METHODS FOR LARGE AND COMPLEX DATA SETS, 3 Credits**
Provides students with the tools and experience to analyze big and messy data and work effectively in a data science team. Covers the tools to handle big data and answer statistical questions based on the data. Includes three big data analysis projects that students work on in groups. Focuses on proper use of modern data analysis techniques related to regression, classification and clustering for data coming from a variety of application fields. R will be the lingua franca.
**Prerequisite:** ST 512 with C or better or ST 517 with C or better or ST 552 with C or better or ST 412 with C or better
**Available via Ecampus**

**ST 539, SURVEY METHODS, 3 Credits**
Survey design, data collection and analysis, general methodology.
**Recommended:** ST 201 or ST 351

**ST 541, PROBABILITY, COMPUTING, AND SIMULATION IN STATISTICS, 4 Credits**
**Recommended:** ST 422 or ST 522

**ST 543, APPLIED STOCHASTIC MODELS, 3 Credits**
Development of stochastic models commonly arising in statistics and operations research, such as Poisson processes, birth-and-death processes, discrete-time and continuous-time Markov chains, renewal and Markov renewal processes. Analysis of stochastic models by simulation and other computational techniques.
**Recommended:** (ST 421 or ST 521) and experience with a high-level programming language or mathematical computation package.

**ST 551, STATISTICAL METHODS, 4 Credits**
Properties of t, chi-square and F tests; randomized experiments; sampling distributions and standard errors of estimators, delta method, comparison of several groups of measurements; two-way tables of measurements.
**Recommended:** Concurrent enrollment in MTH 341 and (ST 422 or ST 522)

**ST 552, STATISTICAL METHODS, 4 Credits**
Simple and multiple linear regression including polynomial regression, indicator variables, weighted regression, and influence statistics, nonlinear regression and linear models for binary data.
**Prerequisite:** ST 551 with C or better
**Recommended:** ST 422 or ST 522.

**ST 553, STATISTICAL METHODS, 4 Credits**
Principles and analysis of designed experiments, including factorial experiments, analysis of covariance, random and mixed effect models. Lec/lab.
**Prerequisite:** ST 553 with C or better

**ST 555, ADVANCED EXPERIMENTAL DESIGN, 3 Credits**
Designs leading to mixed models including split plots, repeated measures, crossovers and incomplete blocks. Introduction to experimental design in industry including confounding, fractional factorials and response surface methodology. Analysis of unbalanced data.
**Prerequisite:** ST 553 with C or better

**ST 557, APPLIED MULTIVARIATE ANALYSIS, 3 Credits**
Multivariate data structures, linear combinations; principal components, factor and latent structure analysis, canonical correlations, discriminant analysis; cluster analysis, multidimensional scaling. Not offered every year.
**Recommended:** (ST 421 or ST 512) and (MTH 252 or MTH 245)

**ST 558, MULTIVARIATE ANALYTICS, 3 Credits**
Basics of matrix algebra, principal components analysis, cluster analysis, factor analysis, multidimensional scaling.
**Prerequisite:** ST 518 with C- or better
**Available via Ecampus**

**ST 559, BAYESIAN STATISTICS, 3 Credits**
Bayesian statistics for data analysis. Characterizations of probability; comparative (Bayesian versus frequentist) inference; prior, posterior and predictive distributions; hierarchical modeling. Computational methods include Markov Chain Monte Carlo for posterior simulation.
**Recommended:** ST 562

**ST 561, THEORY OF STATISTICS, 4 Credits**
Distributions of functions of random variables, joint and conditional distributions, sampling distributions, convergence concepts, order statistics. Lec/rec.
**Recommended:** ST 422 or ST 522
ST 562, THEORY OF STATISTICS, 4 Credits
Sufficiency, exponential families, location and scale families; point estimation: maximum likelihood, Bayes, and unbiased estimators; asymptotic distributions of maximum likelihood estimators; Taylor series approximations.
Prerequisite: ST 561 with C or better
Recommended: ST 422 or ST 522

ST 563, THEORY OF STATISTICS, 4 Credits
Hypothesis testing: likelihood ratio, Bayesian, and uniformly most powerful tests; similar tests in exponential families; asymptotic distributions of likelihood ratio test statistics; confidence intervals.
Prerequisite: ST 562 with C or better
This course is repeatable for 4 credits.

ST 565, TIME SERIES, 3 Credits
Analysis of serially correlated data in both time and frequency domains. Autocorrelation and partial autocorrelation functions, autoregressive integrated moving average models, model building, forecasting, filtering, smoothing, spectral analysis, frequency response studies. Offered winter term in even years.
Recommended: (ST 412 or ST 512) and (ST 422 or ST 522)

ST 566, TIME SERIES ANALYTICS, 3 Credits
Focuses on statistical and analytical tools for analyzing data that are observed sequentially over time. Specific topics can vary term to term, and could include methods for exploratory time series analysis, linear time series models (ARMA, ARIMA), forecasting, spectral analysis and state-space models. The focus will be on applied problems, though some mathematical statistics is necessary for a solid understanding of the statistical issues. This course is designed for students in Data Analytics MS and Certificate programs.
Prerequisite: ST 516 with C or better and ST 517 [C] and ST 518 [C]

ST 567, SPATIAL STATISTICS, 3 Credits
The analysis of spatial data. Graphical tools for exploring spatial data, geostatistics, variogram estimation, kriging, areal models, hierarchical spatial models, and spatio-temporal modelling. Offered winter term in odd years.
Recommended: (ST 412 or ST 512) and (ST 422 or ST 522)

ST 592, STATISTICAL METHODS FOR GENOMICS RESEARCH, 3 Credits
Lectures include an overview of statistical methods commonly applied in genomics research. Specific methods can vary term to term, and could include cluster analysis, decision trees, dimension reduction tools, regression models, multiple testing adjustment, variable selection methods, etc. Journal clubs include team-based review and presentations of landmark papers in both statistical methodology and genomics research. Research experience includes whole-term collaboration between students from statistics and other disciplines on real projects.
Recommended: ST 411 or ST 511 or a higher level course such as ST 551

ST 595, CAPSTONE PROJECT, 3 Credits
Provides an opportunity for students to integrate and apply the analytics skills learned in MS in Data Analytics program to solve real-world problems and to interpret and communicate their results. Student teams will engage in the entire process of solving data science projects in realistic settings, from placing the problem into appropriate statistical framework to applying suitable analytic methods to the problem. Problem solving, written and oral communication skills will be emphasized.
Prerequisite: ST 516 with C or better and ST 517 [C] and ST 518 [C] and ST 558 [C]
Available via Ecampus

ST 599, SPECIAL TOPICS, 1-4 Credits
May be repeated for credit when topic varies.
This course is repeatable for 4 credits.

ST 601, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

ST 603, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

ST 606, PROJECTS, 1-16 Credits
Section 1: Projects; Section 2: Teaching Experience, graded P/N; Section 3: Directed Work, graded P/N.
This course is repeatable for 16 credits.

ST 623, GENERALIZED REGRESSION MODELS, 3 Credits
Maximum likelihood analysis for frequency data; regression-type models for binomial and Poisson data; iterative weighted least squares and maximum likelihood; analysis of deviance and residuals; over-dispersion and quasilikelihood models; log-linear models for multidimensional contingency tables.
Prerequisite: ST 553 with C or better and ST 563 [C]

ST 625, SURVIVAL ANALYSIS, 3 Credits
Prepares students to understand and analyze survival data. Concepts to be discussed include: hazard function (failure rate function); nonparametric likelihood; empirical processes; empirical distribution function; censoring (mostly right independent censoring); Kaplan-Meier estimator; Bias of the KM estimator; Cox proportional hazards model; Accelerated Failure Time Model; Partial Likelihood; log-rank test.
Prerequisite: ST 553 with C or better or ST 563 with C or better
Z 361, INVERTEBRATE BIOLOGY, 3 Credits
Exploration of the diversity and evolutionary relationships among major invertebrate phyla with an emphasis on morphological features, functional aspects, and life history for each phylum.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C] or BI 212H [C-]) and (BI 213 [C] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-] and (BI 222 [C] or BI 222H [C-]) and (BI 223 [C] or BI 223H [C-])) or (BI 204 [C] and BI 205 [C] and BI 206 [C-])

Z 362, INVERTEBRATE BIOLOGY LABORATORY, 2 Credits
Morphology and anatomy of representative invertebrates introduced in Z 361; diversity within phyla. Study is by dissections and both microscopic and macroscopic examination; field trip fee. Lab fee. Lec/lab.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C] or BI 212H [C-]) and (BI 213 [C] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-] and (BI 222 [C] or BI 222H [C-]) and (BI 223 [C] or BI 223H [C-])) and Z 361 (may be taken concurrently) [C-]
Z 372, VERTEBRATE BIOLOGY LABORATORY, 2 Credits
Classification, identification, and natural history of vertebrates. Includes laboratory examination of specimens and frequent field trips (fee charged) emphasizing Oregon fauna. Lab fee.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-]) and Z 371 (may be taken concurrently) [D-]

Z 374, DIVERSITY OF LIFE: VERTEBRATES, 5 Credits
Examination of vertebrate origins and phylogeny, integrating several disciplines (molecular biology, anatomy, behavioral ecology, and evolution). Emphasizes critical thinking and the scientific process to explore the structural/functional adaptations and evolutionary history of vertebrates. Laboratory activities build scientific skills by exploring current hypotheses and tools for the study of vertebrate evolution.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])

Z 422, COMPARATIVE/FUNCTIONAL VERTEBRATE ANATOMY, 5 Credits
Phylogenetically-based study of the form and function of vertebrate organ systems, including integumentary, musculoskeletal, cardiopulmonary, digestive, and sensory. Lab emphasizes comparative form through dissection, and function through non-invasive experimentation. Lec/lab.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])

Z 423, ENVIRONMENTAL PHYSIOLOGY, 3 Credits
Comparative environmental physiology of animals with emphasis on adaptations to such aspects of the physical environment as temperature, water, ions, and gases. Consideration given to interactions between physiology and environment that influence the local and geographic distribution of animals.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-]) and (CH 123 [C-] or CH 233 [C-] or CH 233H [C-]) or (CH 263 [C-] or CH 263H [C-])

Z 425, EMBRYOLOGY AND DEVELOPMENT, 5 Credits
Prerequisite: (BI 311 with D- or better or BI 311H with D- or better) and (BI 314 [D-] or BI 314H [D-] or BB 314 [D-] or BB 314H [D-])

Z 431, VERTEBRATE PHYSIOLOGY I, 4 Credits
Systems/concepts covered include motor reflexes, autonomic nervous system, digestion/metabolism, renal and osmoregulatory, endocrine and reproductive systems. First in Z 431, Z 432/442 series. Lec/rec.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) and (CH 332 (may be taken concurrently) [C-] or CH 335 (may be taken concurrently) [C-])

Z 432, VERTEBRATE PHYSIOLOGY II, 3 Credits
Systems/concepts covered include blood, immune, lymphatic, cardiovascular, and pulmonary. Second in the Z431, 432/442 series.
Prerequisite: Z 431 with C- or better

Z 438, BEHAVIORAL NEUROBIOLOGY, 3 Credits
Prerequisite: (((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-]) and (CH 123 [C-] or CH 233 [C-] or CH 233H [C-] and (CH 263 [C-] or CH 263H [C-]))

Z 442, VERTEBRATE PHYSIOLOGY LABORATORY, 2 Credits
Experiments and exercises in vertebrate physiology covering systems studied in Z 431 and Z 432. Available to Biology majors. Lab fee.
Prerequisite: Z 431 with C- or better and Z 432 (may be taken concurrently) [C-]

Z 461, MARINE AND ESTUARINE INVERTEBRATE ZOOLOGY, 4 Credits
Comparative survey of eight major invertebrate phyla and many lesser-known phyla. Areas of emphasis will be 1) invertebrate identification, 2) natural history (diversity, habitat, feeding, behavior), and 3) comparative anatomy (adaptive significance of morphological structures). Laboratories and field trips will strongly supplement lecture material. Lec/lab. Taught at Hatfield Marine Science Center.
Prerequisite: (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])
Z 473, HERPETOLOGY, 4 Credits
Exploration of global herpetofauna focusing on taxa of the Pacific Northwest of North America. Identification and natural history of amphibians and reptiles are emphasized, along with a phylogenetic framework, to explore and discuss ideas involving their behavior, evolution, ecology, and conservation. Student projects examine important topics in the field.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])
Available via Ecampus

Z 477, AQUATIC ENTOMOLOGY, 4 Credits
Biology, ecology, collection, and identification of aquatic insects. Two required Saturday field trips. Lec/lab.
Prerequisite: ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])

Z 499, SPECIAL TOPICS, 0-16 Credits
Topics and credits vary.
Equivalent to: Z 499H
This course is repeatable for 16 credits.

Z 499H, SPECIAL TOPICS, 1-16 Credits
Topics and credits vary.
Equivalent to: Z 499
This course is repeatable for 16 credits.