

BIOINFORMATICS, GENOMICS, AND PROTEOMICS (Div III)

Advisory Committee

- Daniel P. Aalberts, Kennedy P. Richardson '71 Professor of Physics; affiliated with: Bioinformatics, Genomics & Pro; on leave Spring 2022
- Duane A. Bailey, A. Barton Hepburn Professor of Computer Science
- Lois M. Banta, Chair and Halvorsen Professor for Distinguished Teaching and Research of Biology
- Julie C. Blackwood, Associate Professor of Mathematics
- Victor A. Cazares, Assistant Professor of Psychology; affiliated with: Neuroscience Program
- Pei-Wen Chen, Assistant Professor of Biology
- Richard D. De Veaux, Chair & C. Carlisle and Margaret Tippit Professor of Statistics
- Joan Edwards, Samuel Fessenden Clarke Professor of Biology
- Amy Gehring, Philip and Dorothy Schein Professor of Chemistry; on leave Fall 2021
- Katie M. Hart, Assistant Professor of Chemistry; on leave 2021-2022
- Cynthia K. Holland, Assistant Professor of Biology
- Bernhard Klingenberg, Professor of Statistics
- David W. Loehlin, Assistant Professor of Biology
- Luana S. Maroja, Associate Professor of Biology, Chair of Biochemistry & Molecular Biology Program; affiliated with: Biochemistry&Molecular Bio Pgr; on leave Fall 2021
- Martha Marvin, Lecturer in Neuroscience
- Manuel A. Morales, Professor of Biology
- Anna M. Plantinga, Assistant Professor of Statistics; on leave 2021-2022
- Robert M. Savage, Charles L. MacMillan Professor in Natural Sciences
- Ben W. Thuronyi, Assistant Professor of Chemistry
- Claire S. Ting, Professor of Biology

Bioinformatics, genomics, and proteomics are rapidly advancing fields that integrate the tools and knowledge from biology, chemistry, computer science, mathematics, physics, and statistics in research at the intersection of the biological and informational sciences. Inspired by the enormous amount of biological data that are being generated from the sequencing of genomes, these new fields will help us pose and answer biological questions that have long been considered too complex to address. Research in genomics, proteomics, and bioinformatics will also significantly impact society affecting medicine, culture, economics, and politics.

The Bioinformatics, Genomics, and Proteomics curriculum involves faculty from the Biology, Chemistry, Computer Science, Mathematics/Statistics, and Physics departments and was designed to provide students with an understanding of these revolutionary new areas of investigation. Students interested in graduate work in bioinformatics, genomics, and proteomics should take the BiGP courses and their prerequisites. Interested students are also encouraged to participate in independent research with members of the advisory faculty as they explore the development of these new fields.

BIGP Courses

BIMO 321 (F) Biochemistry I: Structure and Function of Biological Molecules (QFR)

Cross-listings: BIMO 321 BIOL 321 CHEM 321

Primary Cross-listing

This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules.

Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The in-person laboratory provides further opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays. A laboratory section will also be provided for remote students, which will examine similar topics and techniques through literature and data analysis.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: quizzes, two midterm exams, a final exam, problem sets and performance in the laboratories including lab reports

Prerequisites: BIOL 101 and CHEM 251/255 and CHEM 155/256

Enrollment Limit: 16/lab

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 48

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major; cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIMO 321 (D3) BIOL 321 (D3) CHEM 321 (D3)

Quantative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular problem sets in which quantitative/formal reasoning skills are practiced.

Attributes: BIGP Courses BIMO Required Courses

Fall 2021

LEC Section: 01 MWF 10:00 am - 10:50 am Ben W. Thuronyi

LAB Section: 02 M 1:00 pm - 5:00 pm Ben W. Thuronyi

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 03 T 1:00 pm - 5:00 pm Ben W. Thuronyi

BIMO 322 (S) Biochemistry II: Metabolism (QFR)

Cross-listings: BIOL 322 CHEM 322 BIMO 322

Primary Cross-listing

This lecture course provides an in-depth presentation of the complex metabolic reactions that are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: Lecture three hours per week and laboratory two hours per week.

Requirements/Evaluation: several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of data

Prerequisites: BIOL 101 and CHEM 251/255 or permission of instructor

Enrollment Limit: 60

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 60

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major; cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOL 322 (D3) CHEM 322 (D3) BIMO 322 (D3)

Quantative/Formal Reasoning Notes: The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

Attributes: BIGP Courses BIMO Required Courses

Spring 2022

LAB Section: 03 W 1:00 pm - 4:00 pm Janis E. Bravo

LEC Section: 01 TR 9:55 am - 11:10 am Cynthia K. Holland

LAB Section: 02 T 1:00 pm - 4:00 pm Janis E. Bravo

LAB Section: 04 R 1:00 pm - 4:00 pm Janis E. Bravo

BIOL 202 (F) Genetics (QFR)

Genetics, classically defined as the study of heredity, is today a multidisciplinary field whose principles provide critical insight and tools to most areas of biology and medicine. This course covers the experimental basis for our current understanding of the inheritance, structures, and functions of genes. It introduces approaches used by contemporary geneticists and molecular biologists to explore questions in areas of biology ranging from evolution to medicine. A primary focus of the course is on students developing familiarity with problem solving, the logic and quantitative reasoning required to understand how genetic mechanisms lead to biological patterns. The laboratory part of the course provides an experimental introduction to modern genetic analysis as well as introductions to interpreting genetic reasoning in the primary research literature. Laboratory experiments include investigating chromosome structure using microscopy, integrating multiple streams of evidence to map a mutation to the genome, determining the structure of a DNA plasmid using molecular tools.

Class Format: Lecture: three hours per week, Lab: three hours per week.

Requirements/Evaluation: bi-weekly problem sets; weekly laboratory exercises and laboratory reports; three exams

Prerequisites: BIOL 101 and 102

Enrollment Limit: 120

Enrollment Preferences: students interested in the Biology major

Expected Class Size: 60

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major

Distributions: (D3) (QFR)

Quantative/Formal Reasoning Notes: This course develops quantitative skills through solving problems. Students learn to apply basic calculations and logic to predict the outcomes of biological systems, for example, describing the likelihood that an individual will be affected by an inherited disease. Application of quantitative and logical analysis contributes to a large component of the in-class work and the graded material for the class, in the form of problem sets, exams, and data analysis for lab reports.

Attributes: BIGP Courses BIMO Required Courses

Fall 2021

LAB Section: 04 W 1:00 pm - 4:00 pm Derek Dean

LAB Section: 05 R 1:00 pm - 4:00 pm Derek Dean

LAB Section: 02 M 1:00 pm - 4:00 pm Derek Dean

LEC Section: 01 MWF 11:00 am - 11:50 am David W. Loehlin

LAB Section: 03 T 1:00 pm - 4:00 pm Derek Dean

BIOL 305 (S) Evolution (QFR)

This course offers a critical analysis of contemporary concepts in biological evolution. We focus on the relation of evolutionary mechanisms (e.g., selection, drift, and migration) to long term evolutionary patterns (e.g., evolutionary innovations, origin of major groups, and adaptation). Topics include

micro-evolutionary models, natural and sexual selection, speciation, the inference of evolutionary history, evolutionary medicine among others.

Requirements/Evaluation: independent research project, problem sets, participation in discussions and exams

Prerequisites: BIOL 202

Enrollment Limit: 22

Enrollment Preferences: Seniors and biology majors

Expected Class Size: 22

Grading: yes pass/fail option, yes fifth course option

Unit Notes: satisfies the distribution requirement for the Biology major

Distributions: (D3) (QFR)

Quantative/Formal Reasoning Notes: We will use mathematical models to study population genetics.

Attributes: BIGP Courses BIMO Interdepartmental Electives COGS Related Courses

Spring 2022

LAB Section: 02 W 1:00 pm - 4:00 pm Luana S. Maroja

LAB Section: 03 R 1:00 pm - 4:00 pm Luana S. Maroja

LEC Section: 01 MWF 11:00 am - 11:50 am Luana S. Maroja

BIOL 319 (S) Integrative Bioinformatics, Genomics, and Proteomics Lab (QFR)

Cross-listings: MATH 319 CHEM 319 BIOL 319 PHYS 319 CSCI 319

Primary Cross-listing

What can computational biology teach us about cancer? In this lab-intensive experience for the Genomics, Proteomics, and Bioinformatics program, computational analysis and wet-lab investigations will inform each other, as students majoring in biology, chemistry, computer science, mathematics/statistics, and physics contribute their own expertise to explore how ever-growing gene and protein data-sets can provide key insights into human disease. In this course, we will take advantage of one well-studied system, the highly conserved Ras-related family of proteins, which play a central role in numerous fundamental processes within the cell. The course will integrate bioinformatics and molecular biology, using database searching, alignments and pattern matching, and phylogenetics to reconstruct the evolution of gene families by focusing on the gene duplication events and gene rearrangements that have occurred over the course of eukaryotic speciation. By utilizing high through-put approaches to investigate genes involved in the inflammatory and MAPK signal transduction pathways in human colon cancer cell lines, students will uncover regulatory mechanisms that are aberrantly altered by siRNA knockdown of putative regulatory components. This functional genomic strategy will be coupled with independent projects using phosphorylation-state specific antisera to test our hypotheses. Proteomic analysis will introduce the students to de novo structural prediction and threading algorithms, as well as data-mining approaches and Bayesian modeling of protein network dynamics in single cells. Flow cytometry and mass spectrometry may also be used to study networks of interacting proteins in colon tumor cells.

Class Format: two afternoons of lab, with one hour of lecture, per week. In most weeks, we will meet one day for lecture discussions.

Requirements/Evaluation: lab participation, several short homework assignments, one lab report, a programming project, and a grant proposal

Prerequisites: BIOL 202; students who have not taken BIOL 202 but have taken BIOL 101 and a CSCI course, or CSCI/PHYS 315, may enroll with permission of instructor. No prior computer programming experience is required.

Enrollment Limit: 12

Enrollment Preferences: seniors, then juniors, then sophomores

Expected Class Size: 12

Grading: yes pass/fail option, yes fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

MATH 319 (D3) CHEM 319 (D3) BIOL 319 (D3) PHYS 319 (D3) CSCI 319 (D3)

Quantative/Formal Reasoning Notes: Through lab work, homework sets and a major project, students will learn or further develop their skills in programming in Python, and about the basis of Bayesian approaches to phylogenetic tree estimation.

Attributes: BIGP Courses BIMO Interdepartmental Electives

Not offered current academic year

BIOL 321 (F) Biochemistry I: Structure and Function of Biological Molecules (QFR)

Cross-listings: BIMO 321 BIOL 321 CHEM 321

Secondary Cross-listing

This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The in-person laboratory provides further opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays. A laboratory section will also be provided for remote students, which will examine similar topics and techniques through literature and data analysis.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: quizzes, two midterm exams, a final exam, problem sets and performance in the laboratories including lab reports

Prerequisites: BIOL 101 and CHEM 251/255 and CHEM 155/256

Enrollment Limit: 16/lab

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 48

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major; cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIMO 321 (D3) BIOL 321 (D3) CHEM 321 (D3)

Quantative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular problem sets in which quantitative/formal reasoning skills are practiced.

Attributes: BIGP Courses BIMO Required Courses

Fall 2021

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 03 T 1:00 pm - 5:00 pm Ben W. Thuronyi

LAB Section: 02 M 1:00 pm - 5:00 pm Ben W. Thuronyi

LEC Section: 01 MWF 10:00 am - 10:50 am Ben W. Thuronyi

BIOL 322 (S) Biochemistry II: Metabolism (QFR)

Cross-listings: BIOL 322 CHEM 322 BIMO 322

Secondary Cross-listing

This lecture course provides an in-depth presentation of the complex metabolic reactions that are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: Lecture three hours per week and laboratory two hours per week.

Requirements/Evaluation: several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative

and/or graphic analysis of data

Prerequisites: BIOL 101 and CHEM 251/255 or permission of instructor

Enrollment Limit: 60

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 60

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major; cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOL 322 (D3) CHEM 322 (D3) BIMO 322 (D3)

Quantative/Formal Reasoning Notes: The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

Attributes: BIGP Courses BIMO Required Courses

Spring 2022

LEC Section: 01 TR 9:55 am - 11:10 am Cynthia K. Holland

LAB Section: 04 R 1:00 pm - 4:00 pm Janis E. Bravo

LAB Section: 02 T 1:00 pm - 4:00 pm Janis E. Bravo

LAB Section: 03 W 1:00 pm - 4:00 pm Janis E. Bravo

BIOL 430 (S) Genome Sciences: At the Cutting Edge (WS)

Research in genomics has integrated and revolutionized the field of biology, including areas of medicine, plant biology, microbiology, and evolutionary biology. Moreover, recent developments in "metagenomics" (genomic studies of entire communities of microorganisms in natural environments, such as the mammalian gut and the deep sea) and "metatranscriptomics" (studies of genome wide changes in expression and mRNA levels in natural communities of organisms) have generated unprecedented knowledge about the genomic potential of a community and the in situ biological activity of different ecological niches. In this course we will explore how research in these and related areas, including proteomics, have advanced our fundamental understanding of (1) organisms in the three domains of life, and their interactions and evolutionary relationships; (2) biological systems and environments, such as the human body, extreme environments, and the oceans; (3) strategies for solving global challenges in medicine, agriculture, energy resources, and environmental sciences. During the course, students will meet each week for one hour with a tutorial partner and the instructor. Every other week, students will present a written and oral critical analysis of the assigned research articles. On alternate weeks, students will question/critique the work of their colleague.

Requirements/Evaluation: five (4-5 page) papers, tutorial presentations, and the student's effectiveness as a critic

Prerequisites: BIOL 202

Enrollment Limit: 10

Enrollment Preferences: open to juniors and seniors; senior Biology majors who have not taken a 400-level course

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Unit Notes: BIMO, BIGP; does not satisfy the distribution requirement for the Biology major

Distributions: (D3) (WS)

Writing Skills Notes: Weekly written assignments consisting of four-page critique papers (five total during a semester) and two-page response papers (five total during a semester). Students will receive from the instructor timely comments on their writing skills, with suggestions for improvement.

Attributes: BIGP Courses BIMO Interdepartmental Electives

Not offered current academic year

CHEM 319 (S) Integrative Bioinformatics, Genomics, and Proteomics Lab (QFR)

Cross-listings: MATH 319 CHEM 319 BIOL 319 PHYS 319 CSCI 319

Secondary Cross-listing

What can computational biology teach us about cancer? In this lab-intensive experience for the Genomics, Proteomics, and Bioinformatics program, computational analysis and wet-lab investigations will inform each other, as students majoring in biology, chemistry, computer science, mathematics/statistics, and physics contribute their own expertise to explore how ever-growing gene and protein data-sets can provide key insights into human disease. In this course, we will take advantage of one well-studied system, the highly conserved Ras-related family of proteins, which play a central role in numerous fundamental processes within the cell. The course will integrate bioinformatics and molecular biology, using database searching, alignments and pattern matching, and phylogenetics to reconstruct the evolution of gene families by focusing on the gene duplication events and gene rearrangements that have occurred over the course of eukaryotic speciation. By utilizing high through-put approaches to investigate genes involved in the inflammatory and MAPK signal transduction pathways in human colon cancer cell lines, students will uncover regulatory mechanisms that are aberrantly altered by siRNA knockdown of putative regulatory components. This functional genomic strategy will be coupled with independent projects using phosphorylation-state specific antisera to test our hypotheses. Proteomic analysis will introduce the students to de novo structural prediction and threading algorithms, as well as data-mining approaches and Bayesian modeling of protein network dynamics in single cells. Flow cytometry and mass spectrometry may also be used to study networks of interacting proteins in colon tumor cells.

Class Format: two afternoons of lab, with one hour of lecture, per week. In most weeks, we will meet one day for lecture discussions.

Requirements/Evaluation: lab participation, several short homework assignments, one lab report, a programming project, and a grant proposal

Prerequisites: BIOL 202; students who have not taken BIOL 202 but have taken BIOL 101 and a CSCI course, or CSCI/PHYS 315, may enroll with permission of instructor. No prior computer programming experience is required.

Enrollment Limit: 12

Enrollment Preferences: seniors, then juniors, then sophomores

Expected Class Size: 12

Grading: yes pass/fail option, yes fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

MATH 319 (D3) CHEM 319 (D3) BIOL 319 (D3) PHYS 319 (D3) CSCI 319 (D3)

Quantative/Formal Reasoning Notes: Through lab work, homework sets and a major project, students will learn or further develop their skills in programming in Python, and about the basis of Bayesian approaches to phylogenetic tree estimation.

Attributes: BIGP Courses BIMO Interdepartmental Electives

Not offered current academic year

CHEM 321 (F) Biochemistry I: Structure and Function of Biological Molecules (QFR)

Cross-listings: BIMO 321 BIOL 321 CHEM 321

Secondary Cross-listing

This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The in-person laboratory provides further opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays. A laboratory section will also be provided for remote students, which will examine similar topics and techniques through literature and data analysis.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: quizzes, two midterm exams, a final exam, problem sets and performance in the laboratories including lab reports

Prerequisites: BIOL 101 and CHEM 251/255 and CHEM 155/256

Enrollment Limit: 16/lab

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 48

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major; cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIMO 321 (D3) BIOL 321 (D3) CHEM 321 (D3)

Quantative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular problem sets in which quantitative/formal reasoning skills are practiced.

Attributes: BIGP Courses BIMO Required Courses

Fall 2021

LAB Section: 02 M 1:00 pm - 5:00 pm Ben W. Thuronyi

LAB Section: 03 T 1:00 pm - 5:00 pm Ben W. Thuronyi

LEC Section: 01 MWF 10:00 am - 10:50 am Ben W. Thuronyi

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

CHEM 322 (S) Biochemistry II: Metabolism (QFR)

Cross-listings: BIOL 322 CHEM 322 BIMO 322

Secondary Cross-listing

This lecture course provides an in-depth presentation of the complex metabolic reactions that are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: Lecture three hours per week and laboratory two hours per week.

Requirements/Evaluation: several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of data

Prerequisites: BIOL 101 and CHEM 251/255 or permission of instructor

Enrollment Limit: 60

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 60

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major; cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOL 322 (D3) CHEM 322 (D3) BIMO 322 (D3)

Quantative/Formal Reasoning Notes: The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

Attributes: BIGP Courses BIMO Required Courses

Spring 2022

LAB Section: 04 R 1:00 pm - 4:00 pm Janis E. Bravo

LAB Section: 02 T 1:00 pm - 4:00 pm Janis E. Bravo

LEC Section: 01 TR 9:55 am - 11:10 am Cynthia K. Holland

LAB Section: 03 W 1:00 pm - 4:00 pm Janis E. Bravo

CSCI 136 (F)(S) Data Structures and Advanced Programming (QFR)

This course builds on the programming skills acquired in Computer Science 134. It couples work on program design, analysis, and verification with an introduction to the study of data structures. Data structures capture common ways in which to store and manipulate data, and they are important in the construction of sophisticated computer programs. Students are introduced to some of the most important and frequently used data structures: lists, stacks, queues, trees, hash tables, graphs, and files. Students will be expected to write several programs, ranging from very short programs to more elaborate systems. Emphasis will be placed on the development of clear, modular programs that are easy to read, debug, verify, analyze, and modify.

Requirements/Evaluation: programming and written assignments, quizzes, examinations

Prerequisites: CSCI 134 or equivalent; fulfilling the Discrete Mathematics Proficiency requirement is recommended, but not required

Enrollment Limit: 60(12/lab)

Enrollment Preferences: if the course is over-enrolled, enrollment will be determined by lottery

Expected Class Size: 60

Grading: yes pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantative/Formal Reasoning Notes: This course include regular and substantial problem sets, labs, and/or projects in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIGP Courses

Fall 2021

LEC Section: 02 MWF 10:00 am - 10:50 am Duane A. Bailey

LAB Section: 07 W 1:10 pm - 2:25 pm Aaron M. Williams

LAB Section: 05 R 1:10 pm - 2:25 pm Duane A. Bailey

LAB Section: 06 R 2:35 pm - 3:50 pm Aaron M. Williams

LEC Section: 01 MWF 9:00 am - 9:50 am Duane A. Bailey

LAB Section: 08 W 2:35 pm - 3:50 pm Duane A. Bailey

LAB Section: 04 R 9:55 am - 11:10 am Duane A. Bailey

LEC Section: 03 MWF 11:00 am - 11:50 am Aaron M. Williams

Spring 2022

LEC Section: 02 MWF 10:00 am - 10:50 am Samuel McCauley

LEC Section: 01 MWF 9:00 am - 9:50 am Daniel W. Barowy

LAB Section: 08 R 2:35 pm - 3:50 pm Samuel McCauley

LAB Section: 07 R 1:10 pm - 2:25 pm Daniel W. Barowy

LAB Section: 06 R 2:35 pm - 3:50 pm Daniel W. Barowy

LAB Section: 05 R 1:10 pm - 2:25 pm Samuel McCauley

LAB Section: 04 R 9:55 am - 11:10 am Samuel McCauley

LEC Section: 03 MWF 11:00 am - 11:50 am Samuel McCauley

CSCI 315 (F) Computational Biology

Cross-listings: CSCI 315 PHYS 315

Secondary Cross-listing

This course will provide an overview of Computational Biology, the application of computational, mathematical, statistical, and physical problem-solving techniques to interpret the rapidly expanding amount of biological data. Topics covered will include database searching, DNA sequence alignment, clustering, RNA structure prediction, protein structural alignment, methods of analyzing gene expression, networks, and genome assembly using techniques such as string matching, dynamic programming, hidden Markov models, and expectation-maximization.

Requirements/Evaluation: weekly Python programming assignments, code reviews, problem sets, a few quizzes and a final project

Prerequisites: programming experience (e.g., CSCI 136), mathematics (PHYS/MATH 210 or MATH 150), and physical science (PHYS 142 or 151, or

CHEM 151 or 153 or 155), or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: based on seniority

Expected Class Size: 8

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

CSCI 315 (D3) PHYS 315 (D3)

Attributes: BIGP Courses

Fall 2021

LEC Section: 01 MR 2:35 pm - 3:50 pm Daniel P. Aalberts

CSCI 319 (S) Integrative Bioinformatics, Genomics, and Proteomics Lab (QFR)

Cross-listings: MATH 319 CHEM 319 BIOL 319 PHYS 319 CSCI 319

Secondary Cross-listing

What can computational biology teach us about cancer? In this lab-intensive experience for the Genomics, Proteomics, and Bioinformatics program, computational analysis and wet-lab investigations will inform each other, as students majoring in biology, chemistry, computer science, mathematics/statistics, and physics contribute their own expertise to explore how ever-growing gene and protein data-sets can provide key insights into human disease. In this course, we will take advantage of one well-studied system, the highly conserved Ras-related family of proteins, which play a central role in numerous fundamental processes within the cell. The course will integrate bioinformatics and molecular biology, using database searching, alignments and pattern matching, and phylogenetics to reconstruct the evolution of gene families by focusing on the gene duplication events and gene rearrangements that have occurred over the course of eukaryotic speciation. By utilizing high through-put approaches to investigate genes involved in the inflammatory and MAPK signal transduction pathways in human colon cancer cell lines, students will uncover regulatory mechanisms that are aberrantly altered by siRNA knockdown of putative regulatory components. This functional genomic strategy will be coupled with independent projects using phosphorylation-state specific antisera to test our hypotheses. Proteomic analysis will introduce the students to de novo structural prediction and threading algorithms, as well as data-mining approaches and Bayesian modeling of protein network dynamics in single cells. Flow cytometry and mass spectrometry may also be used to study networks of interacting proteins in colon tumor cells.

Class Format: two afternoons of lab, with one hour of lecture, per week. In most weeks, we will meet one day for lecture discussions.

Requirements/Evaluation: lab participation, several short homework assignments, one lab report, a programming project, and a grant proposal

Prerequisites: BIOL 202; students who have not taken BIOL 202 but have taken BIOL 101 and a CSCI course, or CSCI/PHYS 315, may enroll with permission of instructor. No prior computer programming experience is required.

Enrollment Limit: 12

Enrollment Preferences: seniors, then juniors, then sophomores

Expected Class Size: 12

Grading: yes pass/fail option, yes fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

MATH 319 (D3) CHEM 319 (D3) BIOL 319 (D3) PHYS 319 (D3) CSCI 319 (D3)

Quantative/Formal Reasoning Notes: Through lab work, homework sets and a major project, students will learn or further develop their skills in programming in Python, and about the basis of Bayesian approaches to phylogenetic tree estimation.

Attributes: BIGP Courses BIMO Interdepartmental Electives

Not offered current academic year

NSCI 322 (S) From Order to Disorder(s): The Role of Genes & the Environment in Psychopathology

Cross-listings: NSCI 322 PSYC 312

Secondary Cross-listing

This course examines how experimental methods in neuroscience can be used to understand the role of nature (genes) and nurture (the environment) in shaping the brain and behavior. In particular, we will explore how neuroscience informs our understanding of psychiatric disorders such as anxiety, depression, and schizophrenia. We will investigate the biological underpinning of these disorders as well as their treatments. Readings will include human studies as well as work based on animal models. Topics will include: the ways in which environmental and genetic factors shape risk and resiliency in the context of psychiatric disease, the neural circuits and peripheral systems that contribute to psychopathology, and the mechanisms through which interventions may act. In the laboratory component of the course, students will gain hands-on experience in using animal models to study complex behavior and their associated neural mechanisms.

Requirements/Evaluation: class presentations, participation in discussions, project proposal (5 pages), empirical project paper (5-7 pages), poster and poster presentation, participation in all phases of the empirical project research experience (experiment design, data collection, data graphing, data analysis) including oral and written presentation of key findings.

Prerequisites: PSYC 212 (same as BIOL 212 or NSCI 201)

Enrollment Limit: 16

Enrollment Preferences: Psychology majors and Neuroscience concentrators

Expected Class Size: 16

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

NSCI 322 (D3) PSYC 312 (D3)

Attributes: BIGP Courses NSCI Group B Electives PSYC Area 1 - Behavioral Neuroscience PSYC Empirical Lab Course

Spring 2022

SEM Section: 01 TR 9:55 am - 11:10 am Victor A. Cazares

LAB Section: 02 W 1:00 pm - 4:00 pm Victor A. Cazares

PHYS 315 (F) Computational Biology

Cross-listings: CSCI 315 PHYS 315

Primary Cross-listing

This course will provide an overview of Computational Biology, the application of computational, mathematical, statistical, and physical problem-solving techniques to interpret the rapidly expanding amount of biological data. Topics covered will include database searching, DNA sequence alignment, clustering, RNA structure prediction, protein structural alignment, methods of analyzing gene expression, networks, and genome assembly using techniques such as string matching, dynamic programming, hidden Markov models, and expectation-maximization.

Requirements/Evaluation: weekly Python programming assignments, code reviews, problem sets, a few quizzes and a final project

Prerequisites: programming experience (e.g., CSCI 136), mathematics (PHYS/MATH 210 or MATH 150), and physical science (PHYS 142 or 151, or CHEM 151 or 153 or 155), or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: based on seniority

Expected Class Size: 8

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

CSCI 315 (D3) PHYS 315 (D3)

Attributes: BIGP Courses

Fall 2021

PHYS 319 (S) Integrative Bioinformatics, Genomics, and Proteomics Lab (QFR)

Cross-listings: MATH 319 CHEM 319 BIOL 319 PHYS 319 CSCI 319

Secondary Cross-listing

What can computational biology teach us about cancer? In this lab-intensive experience for the Genomics, Proteomics, and Bioinformatics program, computational analysis and wet-lab investigations will inform each other, as students majoring in biology, chemistry, computer science, mathematics/statistics, and physics contribute their own expertise to explore how ever-growing gene and protein data-sets can provide key insights into human disease. In this course, we will take advantage of one well-studied system, the highly conserved Ras-related family of proteins, which play a central role in numerous fundamental processes within the cell. The course will integrate bioinformatics and molecular biology, using database searching, alignments and pattern matching, and phylogenetics to reconstruct the evolution of gene families by focusing on the gene duplication events and gene rearrangements that have occurred over the course of eukaryotic speciation. By utilizing high through-put approaches to investigate genes involved in the inflammatory and MAPK signal transduction pathways in human colon cancer cell lines, students will uncover regulatory mechanisms that are aberrantly altered by siRNA knockdown of putative regulatory components. This functional genomic strategy will be coupled with independent projects using phosphorylation-state specific antisera to test our hypotheses. Proteomic analysis will introduce the students to de novo structural prediction and threading algorithms, as well as data-mining approaches and Bayesian modeling of protein network dynamics in single cells. Flow cytometry and mass spectrometry may also be used to study networks of interacting proteins in colon tumor cells.

Class Format: two afternoons of lab, with one hour of lecture, per week. In most weeks, we will meet one day for lecture discussions.

Requirements/Evaluation: lab participation, several short homework assignments, one lab report, a programming project, and a grant proposal

Prerequisites: BIOL 202; students who have not taken BIOL 202 but have taken BIOL 101 and a CSCI course, or CSCI/PHYS 315, may enroll with permission of instructor. No prior computer programming experience is required.

Enrollment Limit: 12

Enrollment Preferences: seniors, then juniors, then sophomores

Expected Class Size: 12

Grading: yes pass/fail option, yes fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

MATH 319 (D3) CHEM 319 (D3) BIOL 319 (D3) PHYS 319 (D3) CSCI 319 (D3)

Quantative/Formal Reasoning Notes: Through lab work, homework sets and a major project, students will learn or further develop their skills in programming in Python, and about the basis of Bayesian approaches to phylogenetic tree estimation.

Attributes: BIGP Courses BIMO Interdepartmental Electives

Not offered current academic year

PSYC 312 (S) From Order to Disorder(s): The Role of Genes & the Environment in Psychopathology

Cross-listings: NSCI 322 PSYC 312

Primary Cross-listing

This course examines how experimental methods in neuroscience can be used to understand the role of nature (genes) and nurture (the environment) in shaping the brain and behavior. In particular, we will explore how neuroscience informs our understanding of psychiatric disorders such as anxiety, depression, and schizophrenia. We will investigate the biological underpinning of these disorders as well as their treatments. Readings will include human studies as well as work based on animal models. Topics will include: the ways in which environmental and genetic factors shape risk and resiliency in the context of psychiatric disease, the neural circuits and peripheral systems that contribute to psychopathology, and the mechanisms through which interventions may act. In the laboratory component of the course, students will gain hands-on experience in using animal models to study complex behavior and their associated neural mechanisms.

Requirements/Evaluation: class presentations, participation in discussions, project proposal (5 pages), empirical project paper (5-7 pages), poster and poster presentation, participation in all phases of the empirical project research experience (experiment design, data collection, data graphing, data analysis) including oral and written presentation of key findings.

Prerequisites: PSYC 212 (same as BIOL 212 or NSCI 201)

Enrollment Limit: 16

Enrollment Preferences: Psychology majors and Neuroscience concentrators

Expected Class Size: 16

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

NSCI 322 (D3) PSYC 312 (D3)

Attributes: BIGP Courses NSCI Group B Electives PSYC Area 1 - Behavioral Neuroscience PSYC Empirical Lab Course

Spring 2022

LAB Section: 02 W 1:00 pm - 4:00 pm Victor A. Cazares

SEM Section: 01 TR 9:55 am - 11:10 am Victor A. Cazares

STAT 410 (F) Statistical Genetics (QFR)

Genetic studies explore patterns of genetic variation in populations and the effect of genes on diseases or traits. This course provides an introduction to statistical and computational methods for genetic studies. Topics will include Mendelian traits (such as single nucleotide polymorphisms), genome-wide association studies, pathway-based analysis, and methods for population genetics. Students will be introduced to some of the major computational tools for genetic analysis, including PLINK and R/Bioconductor. The necessary background in genetics and biology will be provided alongside the statistical and computational methods.

Requirements/Evaluation: project work, homework, exams, and contribution to discussion

Prerequisites: STAT 346 and STAT 360, or permission of instructor

Enrollment Limit: 14

Enrollment Preferences: Statistics majors, juniors and seniors

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantative/Formal Reasoning Notes: This is a statistics class with a focus on mathematical, computational, and data analysis skills as well as appropriate practical application of analysis methods.

Attributes: BIGP Courses PHLH Statistics Courses

Not offered current academic year