COMPUTATIONAL BIOLOGY - MINOR

Computational biology is an interdisciplinary field that develops and applies computational methods to understand biological systems and address societal challenges.

The Computational Biology Minor is a cross-college minor that welcomes students from a diversity of majors. Students come together from disciplines in biology, math, computer science and engineering in interdisciplinary learning settings. The minor curriculum is intentionally designed to provide students overlap with their respective computational and biological expertise while challenging students to integrate core concepts and skills.

The minor teaches students to combine computational thinking and algorithms to tackle complex biological systems and topics like epidemiology, biotechnology, precision medicine & human health, genetics & genomics, environmental systems, and scientific research. Students learn:

- Computational biology core concepts and experimental techniques.
- Representing and understanding biological data and patterns.
- Biologically relevant skills in applied math, data science & statistics, and computing.
- Modeling and predicting biological processes and dynamics.
- Biological phenomena under uncertainty with probabilistic and statistical analyses.

Visit the Computational Biology Minor webpage (https://www.colorado.edu/biofrontiers/cbiominor/) for the most recent information.

Requirements

A prerequisite is Calculus I or equivalent with a C- or better such as provided by MATH 1300/MATH 1310/APPM 1345/APPM 1350. Students must have a minimum cumulative GPA of 2.500 to declare this minor. Students interested in declaring should visit the Computational Biology Minor webpage (https://www.colorado.edu/biofrontiers/cbiominor/) and submit an Interest Form. A cumulative GPA of 2.000 or better is required in the courses that are used to satisfy the minor. Each individual course that is used to satisfy the minor must be passed with a C- or better.

Required Courses and Credits

The minor is divided into three course areas: Skills, BioElectives, and Data & Structure + Bioprocesses. The common pathways through the minor are: a computing or math background, which fulfills most Skills coursework, or a biology background, which fulfills BioElective coursework. Data & Structure + Bioprocesses course offerings emphasize the integration of Skills and BioElective core concepts. Completion of 8 courses from the three course areas is required for the minor; courses may not double count to satisfy multiple minor requirements. Relevant coursework can be petitioned. Course lists are maintained on the Computational Biology Minor webpage (https://www.colorado.edu/biofrontiers/cbiominor/).

Code	Title	Credit Hours
Skills		
Mathematical Biology		*3-4*
Choose one:		
CSCI 2897	Calculating Biological Quantities	
APPM 2360	Introduction to Differential Equations with Linear Algebra	
MATH 3430	Ordinary Differential Equations	
Data Science & Statistics		*3-4*
Choose one:		
MCDB 3450	Biological Data Science (recommended)	
CSCI 3022	Introduction to Data Science with Probability and Statistics (recommended)	
CHEN 3010	Applied Data Analysis	
EBIO 4410	Biological Statistics	
IPHY 2800		
IPHY 3280	Intro to Data Science and Biostatistics	
MATH 3510	Introduction to Probability and Statistics	
PSYC 2111	Psychological Science I: Statistics	
STAT 2600	Introduction to Data Science	
STAT 4000	Statistical Methods and Application I	
Computing		*6-8*
Choose one, two-course sequence:		
APPM 1650 & APPM 3650	Python for Math and Data Science Applications and Algorithms and Data Structures in Python	
CSCI 1300 & CSCI 2270	Computer Science 1: Starting Computing and Computer Science 2: Data Structures	
CSCI 1320 & CSCI 2270	and Computer Science 2: Data Structures	
ASEN 1320 & CSCI 2270	Aerospace Computing and Engineering Applications and Computer Science 2: Data Structures	
CSCI 1200 & INFO 2201	Introduction to Computational Thinking and Programming for Information Science 2	
INFO 1701 & INFO 2201	Programming for Information Science 1 and Programming for Information Science 2	
BioElectives		**3-4**
Choose one (from any biological area): [1]		
Biochemistry		
BCHM 4611	Principles of Biochemistry	
BCHM 4720	Metabolic Pathways and Human Disease	
BCHM 4740	Biochemistry of Gene Transmission, Expression and Regulation	
Ecology & Evolutionary Biology		
Petition any upper-division EBIO course focused in biological knowledge and theory, e.g.:		
EBIO 3040	Conservation Biology	
EBIO 3080	Evolutionary Biology	
EBIO 3400	Microbiology	

Environmental Studies		
ENVS 3040	Conservation Biology	
ENVS 4185	Geomicrobiology	
Integrative Physiology		
IPHY 3410	Human Anatomy	
IPHY 3430	Human Physiology	
Molecular & Cellular Biology		
MCDB 3135	Molecular Biology	
MCDB 3145	Cell Biology	
MCDB 3150	Biology of the Cancer Cell	
MCDB 3160	Infectious Disease	
MCDB 3501	Structural Methods for Biological Macromolecules	
MCDB 3650	The Brain - From Molecules to Behavior	
Data & Structure + Bioprocesses		**9-10**
Choose three (with at least one course from each list below) to explore biological data and modeling:		
Data & Structure		
CSCI 3352	Biological Networks	
MCDB 4520	Bioinformatics and Genomics	
Bioprocesses		
CSCI 4118	Software Engineering for Scientists	
CSCI 4314	Dynamic Models in Biology	
APPM 4370	Computational Neuroscience	
APPM 4390	Modeling in Mathematical Biology	
BCHM 4631	Statistical and Computational Analysis of the Human Genome	
EBIO 4290	Phylogenetics and Comparative Biology	
EBIO 4420	Computational Biology	
EBIO 4700	Quantitative Genetics	
MCDB 4312	Quantitative Optical Imaging	
PHYS 4560	Introduction to Biophysics	
Total Credit Hours		**24-30**

[1] BioElectives have prerequisite lectures or labs prior to enrollment, and we list the approximate number of them for students on the Computational Biology Minor webpage (https://www.colorado.edu/biofrontiers/cbiominor/). If a biological area of interest is not (fully) represented above, please contact CBIOminor@colorado.edu to petition BioElectives.

Learning Outcomes

- Effectively identify and communicate Computational Biology topics and applications to specialists and non-specialists.
- Reframe and evaluate biological research questions in the context of computational theory and techniques.
- Contextualize data and modeling problems based on biological principles and the scientific discovery process.
- Collect and access biological data sources to study Computational Biology challenges.
- Evaluate methods of biological data collection, validation, extension, and reproducibility.
- Use and/or build computer-based systems, programs, and algorithms based in software design principles.
- Model structured biological data and systems using computational techniques.
- Predict and interpret biological phenomena under uncertainty with probabilistic and statistical analyses.