

Bioinformatics and Computational Biology Undergraduate

Undergraduate study

Undergraduate study in BCBio is jointly administered by the Department of Computer Science, the Department of Genetics, Development, and Cell Biology, and the Department of Mathematics. The undergraduate B.S. degree is offered through the College of Liberal Arts and Sciences.

Bioinformatics and Computational Biology is an interdisciplinary science at the interfaces of the biological, informational and computational sciences. The science focuses on a variety of topics. These include gene identification, expression, and evolution; RNA, protein, and genome structure; and molecular and cellular systems and networks. The large group of participating faculty provides students with a multidimensional perspective on bioinformatics and computational biology and presents them with broad range of possibilities to get involved in research.

This major will prepare students for careers at the interfaces of biological, informational and computational sciences. BCBio graduates with a B.S. seeking direct employment will find ready markets for their talents in agricultural and medical biotechnology industries, as well as in academia, national laboratories, and clinics. Although some students find employment directly after their baccalaureate training, many students will continue their education in one of the many excellent graduate programs in bioinformatics and computational biology that now exist.

Participation in this field requires that students achieve a high level of competence not only in biology, but also in mathematics, computer science, and statistics. As a result, the program includes required courses from many different disciplines. Graduates demonstrate an above-average ability to synthesize methods from these different disciplines to solve problems.

In addition to basic degree requirements listed in the Curriculum in Liberal Arts and Sciences (www.las.iastate.edu/academics/generaleducation/), BCBio majors must satisfy the following requirements:

A. Complementary Courses for the BCBio Major (34 cr)

One of the following	12
CHEM 177 & 177L & CHEM 178	General Chemistry I and Laboratory in General Chemistry I and General Chemistry II
CHEM 201 & 201L & CHEM 331	Advanced General Chemistry and Laboratory in Advanced General Chemistry and Organic Chemistry I
PHYS 221	Introduction to Classical Physics I 5
STAT 330 or STAT 341	Probability and Statistics for Computer Science 3
STAT 430	Introduction to the Theory of Probability and Statistics I 3
STAT 430	Empirical Methods for the Computational Sciences 3
BIOL 211	Principles of Biology I 3
BIOL 211L	Principles of Biology Laboratory I 1
BIOL 212	Principles of Biology II 3
BIOL 212L	Principles of Biology Laboratory II 1
BIOL 314	Principles of Molecular Cell Biology 3
Total Credits	34

B. Core Courses Within the BCBio Major (48 cr)

GEN 313	Principles of Genetics	3
GEN 313L	Genetics Laboratory	1
GEN 409	Molecular Genetics	3
COM S 227	Introduction to Object-oriented Programming	4
COM S 228	Introduction to Data Structures	3
COM S 363	Introduction to Database Management Systems	3
COM S 330 or CPR E 310	Discrete Computational Structures / Theoretical Foundations of Computer Engineering	3
MATH 165	Calculus I	4
MATH 166	Calculus II	4
MATH 265	Calculus III	4

MATH 207	Matrices and Linear Algebra	3
BCBIO 110	BCBIO Orientation	0.5
BCBIO 211	Introduction to Bioinformatics and Computational Biology	3
BCBIO 401	Fundamentals of Bioinformatics and Computational Biology I	3
BCBIO 402	Fundamentals of Bioinformatics and Computational Biology II	3
BCBIO 490 or BCBIO 491	Independent Study / Team Research Projects.	1-5
Total Credits		45.5-49.5

C. Support Electives

3-9 credits to be chosen from the following list:

BCB 593	Workshop in Bioinformatics and Computational Biology	1
BCB 596	Genomic Data Processing	3
PHYS 222	Introduction to Classical Physics II	5
BBMB 404	Biochemistry I	3
BBMB 405	Biochemistry II	3
BIOL 315	Biological Evolution	3
BIOL 423	Developmental Biology	3
BIOL 462	Evolutionary Genetics	3
BIOL 465	Morphometric Analysis	4
BIOL 472	Community Ecology	3
GEN 340	Human Genetics	3
GEN 410	Analytical Genetics	3
STAT 342	Introduction to the Theory of Probability and Statistics II	3
STAT 402	Statistical Design and the Analysis of Experiments	3
STAT 416	Statistical Design and Analysis of Gene Expression Experiments	3
STAT 432	Applied Probability Models	3
STAT 480	Statistical Computing Applications	3
MATH 266 or MATH 267	Elementary Differential Equations and Laplace Transforms	3-4
MATH 304	Elementary Differential Equations and Laplace Transforms	3
MATH 314	Introductory Combinatorics	3
MATH 385	Graphs and Networks	3
MATH 481	Introduction to Partial Differential Equations	3
MATH 481	Numerical Methods for Differential Equations and Interpolation	3

Com S and Cpr E courses at the 300 level and above.

D. The communications and English proficiency requirements of the LAS college are met by:

ENGL 150	Critical Thinking and Communication	3
ENGL 250 or ENGL 250H	Written, Oral, Visual, and Electronic Composition / Written, Oral, Visual, and Electronic Composition: Honors	3
And one of the following:		
ENGL 309	Report and Proposal Writing	
ENGL 312	Biological Communication	
ENGL 314	Technical Communication	

The lowest grade acceptable in ENGL 150 Critical Thinking and Communication, ENGL 250 Written, Oral, Visual, and Electronic Composition or ENGL 250H Written, Oral, Visual, and Electronic Composition: Honors is C-.

Courses primarily for undergraduates:

BCBIO 110. BCBIO Orientation.

(1-0) Cr. 0.5. F.

First 8 weeks. Orientation to the area of bioinformatics and computational biology. For students considering a major in BCBIO. Specializations and career opportunities. Offered on a satisfactory-fail basis only.

BCBIO 211. Introduction to Bioinformatics and Computational Biology.

(3-0) Cr. 3. S.

Perl programming, molecular biology, biological databases, sequence alignment, homology search, identification of sequence patterns, construction of phylogenetic trees, gene function prediction, gene structure prediction, genomic annotation and comparative genomics.

BCBIO 401. Fundamentals of Bioinformatics and Computational Biology I.
(3-0) Cr. 3. F. *Prereq: BCBIO 211 and basic programming experience (e.g. COM S 207, COM S 208, COM S 227 or permission of instructor)*

Application of computer science to molecular biology. String algorithms, sequence alignments, indexing data structures, homology search methods, pattern recognition, fragment assembly, genome annotation, construction of bioinformatics databases, and gathering and distribution of biological information with the Internet.

BCBIO 402. Fundamentals of Bioinformatics and Computational Biology II.
(3-0) Cr. 3. S. *Prereq: BCBIO 401*

Genomics: Gene structure prediction, gene function prediction and comparative genomics. Post-genomics: Gene expression studies, DNA microarrays, next-generation sequencing of transcriptome. Structural biology: Protein and RNA structure predictions, structure representation, comparison and visualization. Systems biology: Signal transduction pathway inference, biological networks and systems.

BCBIO 442. Bioinformatics and Computational Biology Techniques.
(0.2-0.5) Cr. 0.5. Repeatable, maximum of 2 credits. S.SS. *Prereq: BIOL 314 recommended*

Modular minicourses consisting of guided tutorials and hands-on computer software exercises focused on fundamental problems, approaches, and software applications in bioinformatics and computational biology. Offered on a satisfactory-fail basis only. Nonmajor graduate credit.

BCBIO 442A. Bioinformatics and Computational Biology Techniques: Sequence Database Searching.
(0.2-0.5) Cr. 0.5. Repeatable, maximum of 2 credits. S.SS. *Prereq: BIOL 314 recommended*

Modular minicourses consisting of guided tutorials and hands-on computer software exercises focused on fundamental problems, approaches, and software applications in bioinformatics and computational biology. Offered on a satisfactory-fail basis only. Nonmajor graduate credit.

BCBIO 442B. Bioinformatics and Computational Biology: Protein Structure Databases, Visualization, and Prediction.
(0.2-0.5) Cr. 0.5. Repeatable, maximum of 2 credits. S.SS. *Prereq: BIOL 314 recommended*

Modular minicourses consisting of guided tutorials and hands-on computer software exercises focused on fundamental problems, approaches, and software applications in bioinformatics and computational biology. Offered on a satisfactory-fail basis only. Nonmajor graduate credit.

BCBIO 442C. Bioinformatics and Computational Biology Techniques: Phylogenetic Analysis.
(0.2-0.5) Cr. 0.5. Repeatable, maximum of 2 credits. S.SS. *Prereq: BIOL 314 recommended*

Modular minicourses consisting of guided tutorials and hands-on computer software exercises focused on fundamental problems, approaches, and software applications in bioinformatics and computational biology. Offered on a satisfactory-fail basis only. Nonmajor graduate credit.

BCBIO 442D. Bioinformatics and Computational Biology Techniques: Microarray Analysis.
(0.2-0.5) Cr. 0.5. Repeatable, maximum of 2 credits. S.SS. *Prereq: BIOL 314 recommended*

Modular minicourses consisting of guided tutorials and hands-on computer software exercises focused on fundamental problems, approaches, and software applications in bioinformatics and computational biology. Offered on a satisfactory-fail basis only. Nonmajor graduate credit.

BCBIO 444. Introduction to Bioinformatics.
(Cross-listed with BCB, BIOL, COM S, CPR E, GEN). (4-0) Cr. 4. F. *Prereq: MATH 165 or STAT 401 or equivalent*

Broad overview of bioinformatics with a significant problem-solving component, including hands-on practice using computational tools to solve a variety of biological problems. Topics include: database searching, sequence alignment, gene prediction, RNA and protein structure prediction, construction of phylogenetic trees, comparative and functional genomics, systems biology. Nonmajor graduate credit.

BCBIO 490. Independent Study.
Cr. 1-5. Repeatable, maximum of 9 credits. F.S.SS. *Prereq: BCBIO 211, junior or senior classification, permission of instructor*
Students in the College of Liberal Arts and Sciences may use no more than 9 credits of BCBIO 490 and 491 toward graduation.

BCBIO 491. Team Research Projects..
Cr. 1-5. Repeatable, maximum of 9 credits. *Prereq: BCBIO 211, junior or senior classification, permission of instructor*
Research projects in bioinformatics and computational biology done by teams of students. Students in the College of Liberal Arts and Sciences may use no more than 9 credits of BCBIO 490 and 491 toward graduation.