

BIOINFORMATICS, BACHELOR OF SCIENCE (COLLEGE OF INFORMATION SCIENCE & TECHNOLOGY)

The Bioinformatics program in the College of Information Science and Technology (IS&T) specifically equips students with a strong foundation in computer science, scripting/programming, algorithms, database development, data management, and reproducible workflow implementation. In addition, fundamental courses in biology, genetics, molecular biology, chemistry, statistics, and discrete mathematics provide students with the ability to analyze and interpret many different types of data. The program curriculum is designed to meet the current demand for professionals equipped with bioinformatics computing skills. The national demand for bioinformatics professionals exceeds current supply, and individuals with the interdisciplinary training that a bioinformatics degree provides are in high demand.

Graduates of our IS&T Bioinformatics degree program go on to careers in software development and engineering, database development and implementation, and positions in the agricultural sector, among other career pathways; our graduates also pursue graduate research and other professional degrees, including medical school (with the addition of only a few courses). The interdisciplinary nature of our program also allows our graduates to transition easily into informatics-adjacent careers in health informatics, public health, and health information technology. Students also have the opportunity to take up to nine graduate credits toward a College of IS&T Master's degree in Biomedical Informatics through our Fast Track program.

Program Educational Objectives

The goals of the Bioinformatics program in the College of IS&T are stated as Program Educational Objectives (PEOs) and are based on the needs of the program's constituencies. PEOs describe the career and professional accomplishments that our program is preparing graduates to achieve. PEOs are used to align the program with the requirements of accrediting bodies such as the Higher Learning Commission (HLC) and Accreditation Board for Engineering and Technology (ABET), which accredits programs in applied science, computing, engineering, and technology.

Graduates of the UNO IS&T Bachelor of Science in Bioinformatics program will:

1. Prepare a portfolio demonstrating strong analytic, problem solving, and critical thinking skills.
2. Apply the scientific method to draw evidence-based conclusions in digital health and biosystems-related areas.
3. Demonstrate proficiency in communication of digital health and biosystems-related topics in both written and oral formats.
4. Exhibit commitment to strong ethical and moral standards in the field.
5. Demonstrate professional competency on current real-world digital health and biosystems-related perspectives.
6. Demonstrate ability to design, implement, deliver, and manage technical solutions to digital health and biosystems-related problems.
7. Apply skills such as reading primary literature, developing testable hypotheses, designing experiments, and analyzing algorithms.
8. Demonstrate proficiency in statistical and quantitative methods in the field.

Student Group

The Mav Club for Bioinformatics (MCBI) provides students with a space to participate in their local UNO community, build fellowship, and support one another in a more informal way. The Club has a student president and a faculty advisor who work together to offer monthly academic seminars as well as recreational events and opportunities for students to socialize informally.

Fast Track

The School of Interdisciplinary Informatics (SI2) has developed a Fast Track program for highly qualified and motivated students providing the opportunity to complete a bachelor's degree and a master's degree in an accelerated time frame. With Fast Track, students may count up to 9 graduate credit hours towards the completion of their undergraduate program as well as the graduate degree program. Students will work with both undergraduate and graduate advisors to ensure graduate classes selected will count toward both programs, should a student wish to earn a graduate degree in a separate College of Information Science & Technology (CIST) area than their undergraduate degree.

Program Specifics:

- This program is available for undergraduate students pursuing any CIST undergraduate degree desiring to pursue an MS in either the same or a related CIST field.
- Students must have completed no less than 60 undergraduate hours.
- Students must have a minimum undergraduate GPA of 3.0.
- Students must complete the Fast Track Approval form and obtain all signatures and submit to the Office of Graduate Studies prior to first enrollment in a graduate course.
- Students will work with their undergraduate advisor to register for the graduate courses.
- A minimum cumulative GPA of 3.0 is required for graduate coursework to remain in good standing.
- Students remain undergraduates until they meet all the requirements for the undergraduate degree and are eligible for all rights and privileges granted undergraduate status including financial aid.
- Near the end of the undergraduate program, formal application to the graduate program is required. All applicants will need to meet any other admission requirements established for the MS in selected CIST program. The application fee will be waived if the applicant contacts the Office of Graduate Studies for a fee waiver code prior to submitting the MS application.
 - Admission to Fast Track does NOT guarantee admission to the graduate program.
 - The admit term must be after the completion term of the undergraduate degree.

Contact

For more information, contact the College of IS&T Academic Advising Office at 402.554.3819.

Website (<https://www.unomaha.edu/college-of-information-science-and-technology/school-of-interdisciplinary-informatics/bioinformatics/>)

Degree Requirements

A minimum of 120 credit hours is required for a Bachelor of Science degree in Bioinformatics. Thirty of the last 36 hours must be University of Nebraska at Omaha courses. Registering for courses without having taken the stated prerequisites could result in administrative withdrawal.

To obtain a Bachelor of Science in Bioinformatics, a student must fulfill the University, College and Departmental requirements. Some courses may satisfy requirements in more than one area, but credit is awarded only once,

thereby reducing the total number of credit hours for the degree to 120. (This total does not include prerequisites.)

Code	Title	Credits
University General Education (46 hours, 19 of which can be satisfied by courses also required by the degree in the areas below)		27
College of IS&T Core		24
Bioinformatics Core		24
Mathematics		11
Biology		16
Chemistry		14
Electives		4
Total Credits		120

Code	Title	Credits
College of IS&T Core Courses for Bioinformatics Majors		
CIST 1400	INTRODUCTION TO COMPUTER SCIENCE I ¹	3
CSCI 1620	INTRODUCTION TO COMPUTER SCIENCE II ¹	3
CIST 2500	INTRODUCTION TO APPLIED STATISTICS FOR IS&T	3
CIST 3110	INFORMATION TECHNOLOGY ETHICS ²	3
CSCI 3320	DATA STRUCTURES	3
CSCI 4830	INTRODUCTION SOFTWARE ENGINEERING	3
CSCI 4850	DATABASE MANAGEMENT SYSTEMS	3
Select one of the following:		3
CSCI/MATH 4150	GRAPH THEORY & APPLICATIONS	
ISQA/CSCI 4890	DATA WAREHOUSING AND DATA MINING	

Mathematics Courses		
MATH 1950	CALCULUS I ³	5
MATH 2030	DISCRETE MATHEMATICS	3
or CSCI 2030	MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE	
ISQA 4150	ADVANCED STATISTICAL METHODS FOR IS&T	3

Bioinformatics Courses		
BIOI 1000	INTRODUCTION TO BIOINFORMATICS ⁴	3
BIOI 2000	FOUNDATIONS OF BIOINFORMATICS	3
BIOI 3000	APPLIED BIOINFORMATICS	3
BIOI 3500	ADVANCED BIOINFORMATICS PROGRAMMING	3
BIOI 4860	BIOINFORMATICS ALGORITHMS	3
BIOI 4870	DATABASE SEARCH AND PATTERN DISCOVERY IN BIOINFORMATICS	3
BIOI 4890	COMPUTERIZED GENETIC SEQUENCE ANALYSIS	3
BIOI 4970	SENIOR PROJECT IN BIOINFORMATICS I	1
BIOI 4980	SENIOR PROJECT IN BIOINFORMATICS II	2

Biology Courses		
BIOL 1450	BIOLOGY I	5
BIOL 2140	GENETICS	4
BIOL 3020	MOLECULAR BIOLOGY OF THE CELL	3
BIOL 4130	MOLECULAR GENETICS	4
or BIOL 4140	CELLULAR BIOLOGY	

Chemistry Courses ⁵

CHEM 1140 & CHEM 1144	FUNDAMENTALS OF COLLEGE CHEMISTRY and FUNDAMENTALS OF COLLEGE CHEMISTRY LABORATORY ⁶	5
CHEM 2210 & CHEM 2214	FUNDAMENTALS OF ORGANIC CHEMISTRY and FUNDAMENTALS OF ORGANIC CHEMISTRY LABORATORY	5
CHEM 3650 & CHEM 3654	FUNDAMENTALS OF BIOCHEMISTRY and FUNDAMENTALS OF BIOCHEMISTRY LABORATORY	4
Total Credits		89

¹ A minimum grade of C is required for CIST 1400 and CSCI 1620 as a prerequisite for all subsequent CSCI courses.

² CIST 3110 counts toward a Humanities requirement.

³ This course will satisfy UNO's General Education Quantitative Literacy requirement.

⁴ BIOI 1000 counts toward a Natural and Physical Sciences requirement.

⁵ Students pursuing the pre-med requirements for the Bioinformatics degree take CHEM 2250, CHEM 2260 and CHEM 2274 in place of CHEM 2210 and CHEM 2214. Pre-Med majors also take either CHEM 4610 Biochemistry of Metabolism **or** two semesters of Biochemistry and the accompanying labs (CHEM 4650, CHEM 4654, CHEM 4660, and CHEM 4664) in place of CHEM 3650 and CHEM 3654 to satisfy the chemistry requirements for the BIOI major.

⁶ CHEM 1140 and CHEM 1144 count toward the Natural and Physical Sciences lecture and lab requirement.

Writing in the Discipline

All UNO students are required to take a writing-in-the-discipline course within their major. Bioinformatics degree students must take CIST 3000

Second Bachelor's Degree for Bioinformatics

General Requirements

Students who have satisfied the requirements for a first bachelor's degree other than Bioinformatics at the University of Nebraska at Omaha must complete a minimum of 30 additional semester hours at the University for a second bachelor's degree.

Bioinformatics Requirements (89 hours)

To obtain Bioinformatics as a second bachelor's degree, students must complete academic requirements for the degree which include 24 credit hours of IS&T core courses, 11 credit hours of Math courses, 16 credit hours of Biology courses, 14 credit hours of Chemistry courses, and 24 credit hours of Bioinformatics courses. Students must consult an academic advisor in the College of IS&T prior to starting this program. Some transfer coursework may apply; however, 30 of the last 36 hours for the degree must be University of Nebraska at Omaha courses.

Minor Offered:

- Bioinformatics Minor (<http://catalog.unomaha.edu/undergraduate/college-information-science-technology/school-interdisciplinary-informatics-si2/bioinformatic-minor/>)

First Year

Fall		Credits
ENGL 1150	ENGLISH COMPOSITION I	3
BIOI 1000	INTRODUCTION TO BIOINFORMATICS	3
CIST 1400	INTRODUCTION TO COMPUTER SCIENCE I	3
MATH 1950	CALCULUS I ¹	5

Free Elective		1
Credits		15
Spring		
BIOL 1450	BIOLOGY I	5
MATH 2030 or CSCI 2030	DISCRETE MATHEMATICS or MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE	3
CSCI 1620	INTRODUCTION TO COMPUTER SCIENCE II	3
BIOI 2000	FOUNDATIONS OF BIOINFORMATICS	3
Credits		14

Second Year

Fall		
ENGL 1160	ENGLISH COMPOSITION II	3
BIOI 3000	APPLIED BIOINFORMATICS	3
CSCI 3320	DATA STRUCTURES	3
CHEM 1140	FUNDAMENTALS OF COLLEGE CHEMISTRY	4
CHEM 1144	FUNDAMENTALS OF COLLEGE CHEMISTRY LABORATORY	1
Credits		14

Spring

CMST 1110 or CMST 2120	PUBLIC SPEAKING FUNDS or ARGUMENTATION AND DEBATE	3
BIOI 3500	ADVANCED BIOINFORMATICS PROGRAMMING	3
BIOL 2140	GENETICS	4
CHEM 2210	FUNDAMENTALS OF ORGANIC CHEMISTRY	4
CHEM 2214	FUNDAMENTALS OF ORGANIC CHEMISTRY LABORATORY	1
Credits		15

Third Year

Fall		
BIOL 3020	MOLECULAR BIOLOGY OF THE CELL	3
CSCI 4850	DATABASE MANAGEMENT SYSTEMS	3
CIST 2500	INTRODUCTION TO APPLIED STATISTICS FOR IS&T	3
Fine Arts & Humanities Requirement		3
Social Science Requirement		3
Credits		15

Spring

CHEM 3650	FUNDAMENTALS OF BIOCHEMISTRY	3
CHEM 3654	FUNDAMENTALS OF BIOCHEMISTRY LABORATORY	1
BIOI 4890	COMPUTERIZED GENETIC SEQUENCE ANALYSIS	3
CSCI 4830	INTRODUCTION SOFTWARE ENGINEERING	3
CIST 3110	INFORMATION TECHNOLOGY ETHICS	3
Free Elective		3
Credits		16

Fourth Year

Fall		
BIOI 4860	BIOINFORMATICS ALGORITHMS	3
BIOI 4970	SENIOR PROJECT IN BIOINFORMATICS I	1
ISQA 4150	ADVANCED STATISTICAL METHODS FOR IS&T	3
CIST 3000	ADVANCED COMPOSITION FOR IS&T	3

Humanities/Global Diversity Requirement	3	
Social Sciences Requirement	3	
Credits		16

Spring

BIOI 4870	DATABASE SEARCH AND PATTERN DISCOVERY IN BIOINFORMATICS	3
BIOI 4980	SENIOR PROJECT IN BIOINFORMATICS II	2
BIOL 4130	MOLECULAR GENETICS	4
CSCI 4150	GRAPH THEORY & APPLICATIONS	3
Social Sciences/US Diversity Requirement		3
Credits		15
Total Credits		120

¹ MATH 1950 - Satisfies General Education Quantitative Literacy requirement

This roadmap is a suggested plan of study and does not replace meeting with an advisor. Please note that students may need to adjust the actual sequence of courses based on course availability. Please consult an advisor in your major program for further guidance.

This plan is not a contract and curriculum is subject to change.

Additional Information About this Plan:

University Degree Requirements: The minimum number of hours for a UNO undergraduate degree is 120 credit hours. Please review the requirements for your specific degree program to determine all requirements for the program. In order to graduate on time (four years for an undergraduate degree), you need to take 30 credit hours each year.

Placement Exams: For Math, English, and Foreign Languages, a placement exam may be required. More information on these exams can be found at <https://www.unomaha.edu/enrollment-management/testing-center/placement-exams/information.php>

Please note that transfer credit or placement exam scores may change a suggested plan of study.

Overview

Graduates of UNO's Bioinformatics (BIOI) program in the College of Information Science & Technology (IS&T) will be able to use their degree to investigate and apply technology to solve bioinformatics problems effectively. Due to a great demand for experts in bioinformatics, the job outlook for those with appropriate training is excellent. The Bioinformatics degree can also serve as a springboard to graduate work or other careers requiring informatics skills coupled with a biological background.

In Nebraska, many current careers in Bioinformatics are classified by the Nebraska Department of Labor as H3 jobs (High Wage, High Skill, High Demand). According to their website, "Occupations are high wage when at least half of their wage measures are at or above the regional average for all occupations. Occupations that require some college, no degree, or a higher level of educational attainment are high skill, as well as occupations that require a high school diploma or equivalent plus long-term on-the-job training, an apprenticeship, or internship/residency. The number of annual openings, net change in employment, and growth rate determine whether an occupation is high demand. An occupation must be High Wage, High Skill, and High Demand to be an H3 occupation."

Jobs in software development and engineering, biostatistics, and bioinformatics are all currently qualified as H3 jobs in Nebraska. Nationally, the need for people with degrees in Bioinformatics is even more apparent, with institutions such as the National Institutes of Health (NIH) integrating the large need for a trained and competent biomedical data science workforce as a central theme in their current strategic plan. The College of

IS&T's Bioinformatics degree program is one of the only programs in the Midwest that provides this type of preparation at the undergraduate level.

Examples of careers for graduates of our undergraduate Bioinformatics degree program include:

- Bioinformatics Specialist *
- Statistician/Biostatistician*
- Software Application Developer*
- Bioinformatics Scientist/Analyst
- Scientific Curator
- Computational Biologist
- Database Programmer
- Database Administrator*
- Consultant
- Data Scientist/Wrangler
- Software Engineer
- Research Scientist*
- Biotech Entrepreneur

*Classified by the Nebraska Department of Labor as an H3 Career

Bioinformatics Curriculum Advisory Committee

The College of IS&T's Bioinformatics (BIOI) and Biomedical Informatics (BMI) faculty hosts an annual BIOI/BMI Curriculum Advisory Committee (CAC) meeting. The CAC is designed to involve alumni and community stakeholders from industry, academia, government, and non-profit organizations to aid the BIOI Undergraduate Program Committee (UPC), BMI Graduate Program Committee (GPC), and BMI Doctoral Program Committee (DPC) in decisions regarding curriculum for each committee's respective program. The CAC's objectives are:

- To review the program curriculum and provide recommendations on how to develop or change programs to address the needs of students in making them "workforce ready."
- To discuss opportunities and potential pathways for students to transition into the workforce through formal (internships, apprenticeships) and informal means.
- To provide input to curriculum committees on how to manage or improve student recruitment to our programs.
- To provide input to curriculum committees on how to manage or improve student retention in our programs.
- To support and encourage involvement of the Omaha metropolitan community in our BIOI/BMI programs.

BIOI 1000 INTRODUCTION TO BIOINFORMATICS (3 credits)

Bioinformatics is a scientific discipline that integrates mathematical and computational techniques with biological knowledge to develop and use computational tools to extract, organize and interpret information from genetic sequence data. The field is growing rapidly with the advancement in molecular technology to sequence the genomes of many different organisms. This course will provide an introduction to the field and will examine some of the problems of interest to bioinformaticians and how these relate to biology, computer science, mathematics and engineering. Topics will include an overview of the biology, mathematics and computer science needed to understand these and tools.

Distribution: Natural/Physical Science General Education course

BIOI 2000 FOUNDATIONS OF BIOINFORMATICS (3 credits)

Bioinformatics is a new scientific discipline that integrates mathematical and computational techniques with biological knowledge to develop and use computational tools to extract, organize and interpret information from genetic sequence data. The field is growing quickly due to rapid advances in sequencing and other biological techniques that allow the genomes of different organisms to be easily sequenced. This course provides an overview of the field and covers the chemical, biological, mathematical and computational foundations of bioinformatics upon which later courses will depend. In addition, it introduces problems of interest to bioinformaticians and the methods and tools used to address them.

Prerequisite(s): BIOI 1000 or BIOL 1450

BIOI 3000 APPLIED BIOINFORMATICS (3 credits)

This course will provide students with the practical skills needed for the analysis of -omics data. Topics covered will include biological databases, molecular biology tools (e.g., primer design, contig assembly), gene prediction and mining, database searches, genome comparison, sequence alignments, phylogenetic inference, gene expression data analyses, functional annotation of protein sequences, protein structure and modeling. Specialized software (e.g., Vector NTI) and widely used web-based computation tools (e.g., Entrez, BLAST, ClustalX, Phylip, PyMOL, and SwissPDBviewer) will be illustrated. Multiple approaches for solving particular problems will be presented.

Prerequisite(s): BIOI 2000 and CIST 1400; or permission of instructor.

BIOI 3500 ADVANCED BIOINFORMATICS PROGRAMMING (3 credits)

Because of the volume and complexity of biological data, advanced programming skills are required for researchers in order to get the most out of their data analyses. This course will provide the expanded programming skills necessary to develop software that can exploit the complex information landscape of bioinformatics. Specific topics covered will include molecular biology basics, Unix/Linux shell programming, Perl and BioPerl, databases and using the Perl DBI, and data visualization.

Prerequisite(s): BIOI 3000 and CSCI 1620; or permission of instructor. CSCI 3320 is strongly recommended but not required.

BIOI 4500 INDEPENDENT STUDY (1-3 credits)

This course allows students to research a topic of their interest that is not available in a formal course. The topic to be studied must be agreed upon by the student and the instructor.

Prerequisite(s): Junior or Senior within the Bioinformatics undergraduate program. Not open to non-degree graduate students.

BIOI 4510 BIOINFORMATICS INTERNSHIP (1-3 credits)

The purpose of this course is to provide the students with an opportunity for practical application and further development of knowledge and skills acquired in the Bioinformatics undergraduate program. The internship gives students professional work experience and exposure to the challenges and opportunities faced by IT professionals in the workplace.

Prerequisite(s): Junior/Senior standing and permission of Director of the School of Interdisciplinary Informatics. Not open to non-degree graduate students.

BIOI 4860 BIOINFORMATICS ALGORITHMS (3 credits)

The main objective of this course is to provide an organized forum for students to understand the foundations of algorithmic design and analysis in the context of health and biological data. The course will present fundamental concepts in algorithms (exhaustive, greedy, graph, heuristic, and more) and explore how those concepts extend to bioinformatics and related fields, such as biomedical informatics, and health informatics. Students will learn about historical context of these algorithms and how they were pivotal in forming more complex modern approaches, and will explore advanced algorithms in their area of interest. Students will also exercise their programming skills with the opportunity to implement and apply bioinformatics algorithms to real data, so to better grasp the technical components of algorithmic design and analysis. (Cross-listed with BMI 8866).

Prerequisite(s): CSCI 3320 or permission of instructor. Prior completion of CSCI 4850 is strongly recommended but not required.

BIOI 4870 DATABASE SEARCH AND PATTERN DISCOVERY IN BIOINFORMATICS (3 credits)

This required course for undergraduate bioinformatics majors provides foundational knowledge on database aspects used in the field and an overview of their applications in bioinformatics, biomedical informatics, and health/clinical informatics. The course begins with a brief review of key concepts in computational molecular biology related to database search/development, database management systems, the difference between primary and secondary databases, and bioinformatics-related aspects of modeling and theory in computer science. The major focus is on the multiple challenges and aspects of bio-database development, search, and pattern discovery. The course uses problem-based learning to help students develop database management skills as they apply to high throughput "-omics." data, the basics of data management, data provenance and governance, standards, and analysis through KDD-based workflows. This course will also consider the fundamentals of artificial intelligence and machine learning as they pertain to bioinformatics, from the perspective of database storage, I/O, and analysis. (Cross-listed with CSCI 8876).

Prerequisite(s): CSCI 4850 or permission of instructor. Not open to non-degree graduate students.

BIOI 4890 COMPUTERIZED GENETIC SEQUENCE ANALYSIS (3 credits)

The goal of this course is to introduce students to major topics in computerized analysis of genetic sequences. In particular the course will allow students to become familiar with the computational tools and software that aid in the modern molecular biology experiments and analysis of experimental results. Following the completion of this course, it is expected that the students will have a basic understanding of the theoretical foundations of the sequence analysis tools and develop competence in evaluating the output from these tools in a biological context. This course will emphasize hands-on experience with the programs for nucleotide and amino acid sequence analysis and molecular phylogeny. (Cross-listed with BMI 8896).

Prerequisite(s): Junior or senior-level standing in the Bioinformatics program or permission from the instructor.

BIOI 4950 SPECIAL TOPICS IN BIOINFORMATICS (3 credits)

This course is intended to provide a mechanism for offering instruction in subject areas that are not covered in other regularly scheduled courses. In general, courses offered under the BIOI 4950 designation will focus on evolving subject areas in bioinformatics.

Prerequisite(s): Prerequisites of a specific offering of BIOI 4950 will be determined by the supervising faculty member and identified in the course proposal. It is anticipated that permission of the faculty member teaching the course will be required for registration.

BIOI 4970 SENIOR PROJECT IN BIOINFORMATICS I (1 credit)

This course is the first part of a two-part series that allows students to work on a guided research project on a specific topic in bioinformatics. The goal of this course is for the student to decide on a research topic and to write a detailed proposal based on this topic that outlines the goals and objectives of the proposed research. The topic and proposal will be approved by the supervising faculty member.

Prerequisite(s): BIOI 4860 and BIOI 4870; BIOI 4870 can be taken concurrently. Senior level status in the Bioinformatics program. Not open to nondegree students.

BIOI 4980 SENIOR PROJECT IN BIOINFORMATICS II (2 credits)

This course is the second part of a two-part series that allows the student to work on a guided research project on a specific topic in bioinformatics. The goal of this course is for the student to perform the research proposed in Part I of the course and to present the results of his or her work. Presentations will be made in the form of a report, written as a scientific research paper, and an oral defense.

Prerequisite(s): Junior or senior-level standing in the Bioinformatics program or permission from the instructor.