Bioinformatics, Bachelor of Science (College of Information Science & Technology)

Bioinformatics is an exciting and rapidly-growing field that uses techniques from the computer and information sciences to interrogate biological systems. It is an interdisciplinary science, bringing together aspects of computer science, molecular biology, chemistry, and mathematics. Specifically, it is the science of developing and utilizing computer databases and algorithms to facilitate and expedite biological research, particularly in the areas of genomics, transcriptomics, proteomics, and more.

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 aims to align with and 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 Research and Teaching Opportunities

The College of IS&T Bioinformatics (BIOI) and Biomedical Informatics (BMI) faculty, staff, and students are invited to participate in a weekly professional journal club and research group meeting, the BIOI Research Group. The BIOI Research Group meets year round and sustains our UNO Bioinformatics community with components of a typical journal club, including research dissemination, practice of student science communication skills, discussion of current events, and planning of social events. Overall, this meeting serves as a venue for support and collaboration between the UNO IS&T Bioinformatics group members.

All Bioinformatics and Biomedical Informatics faculty in the College of IS&T regularly provide opportunities for students to perform research in their respective areas of expertise.

Students in the Bioinformatics degree program are also encouraged to participate in K-12 student mentorship and teaching opportunities through our outreach activities. Our faculty and staff have been involved in outreach activities facilitated by the College of IS&T for many years and continue to participate in them year round to encourage awareness of the Bioinformatics and Biomedical Informatics disciplines. These activities include but are not limited to CodeCrush, iSTEM Afterschool Program, and our Summer Internship Program.

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.

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 (https://catalog.unomaha.edu/search/?P=CIST%203000).

Degree Requirements

A minimum of 120 credit hours is required for a Bachelor of Science degree in Bioinformatics (BSBI). 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 BSBI, 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.)

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>46 hours of University General Education courses (13 hours of which can be satisfied by courses also required by the degree in the areas below; students take 6 hours of coursework that satisfy both the US and global diversity and distribution requirements)</td>
<td>27</td>
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<tr>
<td>24 hours of College of IS&amp;T Core courses</td>
<td>24</td>
<td></td>
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<tr>
<td>24 hours of Bioinformatics courses</td>
<td>24</td>
<td></td>
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<tr>
<td>11 hours of Mathematics courses</td>
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16 hours of Biology courses | 16  
14 hours of Chemistry courses | 14  
4 hours of elective/prerequisite credits | 4  

**Total Credits** | **120**

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<tr>
<th>Code</th>
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<th>Credits</th>
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<tr>
<td>CSCI 1200 &amp; CSCI 1204</td>
<td>COMPUTER SCIENCE PRINCIPLES and COMPUTER SCIENCE PRINCIPLES LABORATORY</td>
<td>3-4</td>
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| CIST 1300 | INTRODUCTION TO WEB DEVELOPMENT | 3  

**College of IS&T Core Courses for Bioinformatics Majors**

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</table>
| CIST 1400 | INTRODUCTION TO COMPUTER SCIENCE I | 3  
| CSCI 1620 | INTRODUCTION TO COMPUTER SCIENCE II | 3  
| CIST 2500 | INTRODUCTION TO APPLIED STATISTICS FOR IS&T | 3  
| CIST 3110 | INFORMATION TECHNOLOGY ETHICS | 3  
| CSCI 3320 | DATA STRUCTURES | 3  
| CSCI 4830 | INTRODUCTION SOFTWARE ENGINEERING | 3  
| CSCI 4850 | DATABASE MANAGEMENT SYSTEMS | 3  

Select one of the following:

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<tr>
<th>Code</th>
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<th>Credits</th>
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| CSCI/MATH 4150 | GRAPH THEORY & APPLICATIONS | 3  
| ENGL | ENGLISH COMPOSITION I | 3  
| ISQA/CSCI 4890 | DATA WAREHOUSING AND DATA MINING | 3  

**Elective/Prerequisite**

1. CHEM 2210 & CHEM 2214 with FUNDAMENTALS OF ORGANIC CHEMISTRY and FUNDAMENTALS OF ORGANIC CHEMISTRY LABORATORY | 5  
2. CHEM 3650 & CHEM 3654 with FUNDAMENTALS OF BIOCHEMISTRY and FUNDAMENTALS OF BIOCHEMISTRY LABORATORY | 4  

**Total Credits** | **92-93**

1. NOTE: A minimum grade of C is required for CIST 1400 and CSCI 1620 as a prerequisite for all subsequent CSCI courses.  
2. NOTE: CIST 3110 counts toward a Humanities requirement.  
3. NOTE: MATH 1950 is required for this degree program. This course will also satisfy UNO’s General Education Quantitative Literacy requirement. Students who do not place into MATH 1950 are responsible for prerequisite courses MATH 1220, MATH 1320, and MATH 1330. MATH 1120/STEM 1120, MATH 1130, and STAT 1530 will not serve as prerequisites for MATH 1950. These courses will satisfy the General Education Quantitative Literacy requirement; however, they do not satisfy the Math requirement for the degree program. Students are highly encouraged to consult with their academic advisor before enrolling in a particular course.  
4. NOTE: BIOI 1000 counts toward a Natural and Physical Sciences requirement.  
5. NOTE: 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. NOTE: CHEM 1140 and CHEM 1144 count toward the Natural and Physical Sciences lecture and lab requirement.

**Minor Offered:**

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

**Freshman**

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<th>Fall</th>
<th>Credits</th>
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| ENGL 1150 | ENGLISH COMPOSITION I | 3  
| BIOI 1000 | INTRODUCTION TO BIOINFORMATICS | 3  
| CIST 1400 | INTRODUCTION TO COMPUTER SCIENCE | 3  
| MATH 1950 | CALCULUS I | 5  

**Credits** | **14**

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<th>Spring</th>
<th>Credits</th>
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| BIOI 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  

**Sophomore**

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<th>Fall</th>
<th>Credits</th>
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</table>
| ENGL 1160 | ENGLISH COMPOSITION II | 3  
| BIOI 3000 | APPLIED BIOINFORMATICS | 3  

**Credits** | **14**
Bioinformatics, Bachelor of Science (College of Information Science & Technology)

CSCI 3320 DATA STRUCTURES 3
CHEM 1140 FUNDAMENTALS OF COLLEGE CHEMISTRY 4
CHEM 1144 FUNDAMENTALS OF COLLEGE CHEMISTRY LABORATORY 1

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<tr>
<th>Credits</th>
<th>14</th>
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**Spring**

CMST 1110 PUBLIC SPEAKING FUNDS 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

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<th>Credits</th>
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**Junior Fall**

BIOI 4860 BIOINFORMATICS ALGORITHMS 3
BIOL 3020 MOLECULAR BIOLOGY OF THE CELL 3
CIST 4850 DATABASE MANAGEMENT SYSTEMS 3
CIST 2500 INTRODUCTION TO APPLIED STATISTICS FOR IS&T 3

Social Sciences 3
Free Elective 1

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<tr>
<th>Credits</th>
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**Spring**

BIOI 4870 DATABASE SEARCH AND PATTERN DISCOVERY IN BIOINFORMATICS 3
CHEM 3650 FUNDAMENTALS OF BIOCHEMISTRY 3
CHEM 3654 FUNDAMENTALS OF BIOCHEMISTRY LABORATORY 1
BIOI 4890 COMPUTERIZED GENETIC SEQUENCE ANALYSIS 3

Free Elective 3
Humanities & Fine Arts 3

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**Senior Fall**

ISQA 4150 ADVANCED STATISTICAL METHODS FOR IS&T 3
BIOI 4970 SENIOR PROJECT IN BIOINFORMATICS I 1
CIST 3110 INFORMATION TECHNOLOGY ETHICS 3

CIST 3000 ADVANCED COMPOSITION FOR IS&T 3
Humanities & Fine Arts/US Diversity 3
Social Sciences 3

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<tr>
<th>Credits</th>
<th>16</th>
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**Spring**

CSCI 4830 INTRODUCTION SOFTWARE ENGINEERING 3
BIOI 4980 SENIOR PROJECT IN BIOINFORMATICS II 2
BIOL 4130 or BIOL 4140 MOLECULAR GENETICS or CELLULAR BIOLOGY 4

CSCI 4150 or CSCI 4890 GRAPH THEORY & APPLICATIONS or DATA WAREHOUSING AND DATA MINING 3

Social Sciences/Global Diversity 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

* indicates a specialized career path in bioinformatics.
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 rapidly with the advancement of 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 tools.

**Distribution:** Natural/Physical Science General Education course

**Prerequisite(s)/Corequisite(s):** BIOL 1450 or permission of instructor.
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)/Corequisite(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 class 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.
Prerequisite(s)/Corequisite(s): Junior or senior-level standing in the Bioinformatics program or permission from the instructor. Not open to nondegree students.

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

BIOI 4990  INDEPENDENT STUDY IN BIOINFORMATICS (1-3 credits)
This is a variable-credit course designed for the junior or senior bioinformatics major who would benefit from independent reading assignments and research-type problems. Independent study enables coverage of topics not taught in scheduled course offerings.
Prerequisite(s)/Corequisite(s): Junior/senior standing, permission of supervising faculty member & approval of Bioinformatics UG Prog Comm Chair. A formal description of the problem area to be investigated, the resources to be used, & the results to be produced must be prepared.