

BIOINFORMATICS (BS/MS)

Bioinformatics is a highly interdisciplinary STEM field that integrates computational and statistical methods for analyzing large biological data sets. Bioinformaticians apply their biological and computational sciences backgrounds to develop, utilize, and optimize new computational tools to organize, synthesize, and analyze the rapidly increasing amount of biological and biomedical data.

Accelerated Bachelor's/Master's programs (ABM) provide significant cost savings to students interested in accelerating their path to an advanced degree. An ABM allows full-time students to complete both an undergraduate and graduate degree within just five years, equating to a lower overall cost than completing both programs separately. The Bioinformatics ABM programs include coursework in Biology, Chemistry, Computer Science, and Statistics as well as hands-on research experience. Students typically apply during the spring semester of their Junior year (Applicants must be at least a Junior based on credit hours and under 1 year from completing the BS degree).

Two ABM programs are available:

- For students majoring in Bioinformatics BS/MS (BIOI BS/ BIOI MS) [This page!]
- For students majoring in Biology BS - Bioinformatics MS (BIOL BS/BIOI MS) [Please follow this link (<https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/biology-bioinformatics-bs-ms/>)!]

The one-year MS component is offered as one of two possible tracks:

1. Thesis track (research-based) for students interested in academic research and advanced degree programs, such as a Ph.D. program.
2. Non-thesis track (internship-based) for students who aim to enter the workforce in an industrial setting, such as Biotech and Pharma

Related Programs

Combined

- Biology/Bioinformatics (BS/MS) (<https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/biology-bioinformatics-bs-ms/>)

Curriculum

An ABM allows full-time students to complete an undergraduate and graduate degree within five years. This is possible because students take Graduate-level courses during their senior year, which earns them Graduate-level credit. Graduate-level credit hours taken during the undergraduate program and then applied toward graduate program requirements will be referred to as Shared Credits. Up to 15 Graduate-level credit hours can be taken during senior year, and a minimum of 15 Graduate-level credit hours will be taken during the MS year.

Code	Title	Hours
Biology Fundamental Courses		
BIOL 101	General Biology I	3
BIOL 282	Genetics	3
BIOL 283	Genetics Laboratory	1
Chemistry Fundamental Courses		

CHEM 160	Chemical Structure and Properties	3
CHEM 180	Chemical Reactivity I	3
CHEM 240	Chemical Reactivity II	3
CHEM 260	Quantitative Methods in Chemistry	3
CHEM 361	Principles of Biochemistry	3

Computer Science Fundamental Courses

COMP 141	Introduction to Computing Tools and Techniques	3
MATH 215	Object-Oriented Programming with Mathematics ¹	3
COMP 231	Data Structures & Algorithms for Informatics	3

Math/Stats Fundamental Courses

MATH 131	Applied Calculus I	3
or MATH 161	Calculus I	
MATH 132	Applied Calculus II	3
or MATH 162	Calculus II	
STAT 335	Introduction to Biostatistics	3

Bioinformatics Fundamental Courses

BIOL 388	Bioinformatics	3
BIOL 387	Genomics	3
or BIOL 392	Metagenomics	
COMP 483	Computational Biology (BS+MS credit)	4
STAT 437	Quantitative Bioinformatics (BS+MS credit)	3

Bioinformatics Electives

Select two of the following:		6
BIOL 390	Molecular Biology Laboratory	
BIOL 565	Exploring Proteins (BS+MS credit ; Fall only)	
or CHEM 465	Special Topics in Biochemistry	
COMP 353	Database Programming ³	
or COMP 379	Machine Learning	

Bioinformatics Research (Select one)

Select one of the following:		1
BIOL 397	Bioinformatics Survey	
BIOL 398	Bioinformatics Internship	
BIOL 399	Bioinformatics Research	

MS Bioinformatics Fundamental Courses (Both Tracks)

BIOL 500	Advanced Bioinformatics (Fall only)	3
BIOL 501	Bioinformatics Seminar	1

Thesis-Track specific courses

UNIV 370	Responsible Conduct in Research and Scholarship	
BIOL 494	Bioinformatics Research Design	
BIOL 499	Bioinformatics Research	
BIOL 595	Thesis Supervision	
+ 2 MS Bioinformatics Elective		

Non-Thesis-Track specific courses

BIOL 498	Bioinformatics Internship	
+ 5 MS Bioinformatics Electives		

Total Hours **93**

NOTE: Required courses within the major also satisfy the following **University Core Curriculum** (<https://catalog.luc.edu/undergraduate/university-requirements/university-core/>) requirements: scientific literacy (6 credits) and quantitative analysis (3 credits)

¹ Maybe substituted with COMP 170 Introduction to Object-Oriented Programming

² CHEM 465 Special Topics in Biochemistry Proteomics (odd years, Spring only)
³ COMP 379 Machine Learning (Fall only)

Designated Courses that may count for Shared Credit for the BS and MS degrees:

Up to three of the listed courses may be taken at the graduate level during senior year and count as *Shared Credits* towards the BS and MS degrees.

Code	Title	Hours
BIOL 495	Special Topics	3
BIOL 495	Special Topics	3
BIOL 565	Exploring Proteins (Fall only)	3
CHEM 465	Special Topics in Biochemistry	3
COMP 453	Database Programming	3
COMP 479	Machine Learning (Fall only)	3
COMP 483	Computational Biology (Spring only)	4
STAT 437	Quantitative Bioinformatics	3

¹ BIOL 495 Special Topics (Metagenomics - Fall only, Genomics - Spring only)
² CHEM 465 Special Topics in Biochemistry (Proteomics - odd years, Spring only)

List of MS Bioinformatics Electives

Code	Title	Hours
Biology		
BIOL 402	Microbiology	3
BIOL 482	Advanced Molec Genetics	3
BIOL 495	Special Topics ¹	3
Chemistry		
CHEM 425	Special Topics in Organic Chemistry ²	3
CHEM 435	Special Topics in Physical Chemistry ³	3
CHEM 455	Special Topics in Analytical Chemistry ⁴	3
CHEM 465	Special Topics in Biochemistry ⁵	3
Computer Science		
COMP 406	Data Mining	3
COMP 413	Intermediate Object-Oriented Development	3
COMP 439	Distributed Systems	3
COMP 453	Database Programming	3
COMP 460	Algorithms & Complexity	3
COMP 471	Theory of Programming Languages	3
COMP 479	Machine Learning	3
COMP 486	Computational Neuroscience	3
Statistics		
STAT 407	Statistical Design	3
STAT 406	Stochastic Processes	3
STAT 408	Applied Regression Analysis	3
STAT 410	Categorical Data Analysis	3
STAT 436	Topics in Biostatistics	3

¹ BIOI 495 Special Topics in Bioinformatics includes topics: Human Genetics, Human Molecular Genetics, Scientific Logic & Critical thinking, Genomics - Spring only, & Metagenomics - Fall only
² CHEM 425 Special Topics in Organic Chemistry (Medicinal Chemistry)
³ CHEM 435 Special Topics in Physical Chemistry (Computational Biochemistry)
⁴ CHEM 455 Special Topics in Analytical Chemistry (Introduction to Spectroscopy)
⁵ CHEM 465 Special Topics in Biochemistry includes topics: Enzymology, Plant Biochemistry, & Protein Crystallography.

Suggested Sequence of Courses

The sequence of courses below is meant to be used as a suggested path for completing coursework. An individual student's completion of requirements depends on course offerings in a given term as well as the start term for a major or graduate study. Students should consult their advisor(s) for assistance with course selection.

These sample course schedules exemplify how students may complete their Bioinformatics major (B.S.), University Core Requirements, and M.S. in Bioinformatics within five years of study. The first is an example for the Non-thesis track, and the second for the thesis track:

Suggested Sequence of Courses - Non-thesis Track

Course	Title	Hours
Year 1		
Fall		
BIOL 101	General Biology I	3
CHEM 160	Chemical Structure and Properties	3
MATH 131	Applied Calculus I	3
CORE: College Writing Seminar		3
CORE: Theology and Religious Studies Tier 1		3
Hours		15
Spring		
CHEM 180	Chemical Reactivity I	3
COMP 141	Introduction to Computing Tools and Techniques	3
MATH 132	Applied Calculus II	3
CORE: Ethics		3
CORE: Theology and Religious Studies Tier 2		3
Hours		15
Year 2		
Fall		
BIOL 282	Genetics	3
BIOL 283	Genetics Laboratory	1
CHEM 240	Chemical Reactivity II	3
MATH 215	Object-Oriented Programming with Mathematics	3
CORE: Historical Knowledge Tier 1		3
CORE: Philosophical Knowledge Tier 1		3
Hours		16
Spring		
CHEM 260	Quantitative Methods in Chemistry	3
COMP 231	Data Structures & Algorithms for Informatics	3

CAS Elective	3
CORE: Historical Knowledge Tier 2	3
CORE: Philosophical Knowledge Tier 2	3
Hours	15

Year 3**Fall**

BIOL 388	Bioinformatics ¹	3
BIOL 392	Metagenomics	3
or BIOL 387	or Genomics	
CAS Elective		3
CAS Language Requirement 1		3
CORE: Literary Knowledge & Experience Tier 1		3

Hours **15**

Spring

CHEM 361	Principles of Biochemistry ¹	3
STAT 335	Introduction to Biostatistics ¹	3
CAS Language Requirement 2		3
CORE: Literary Knowledge & Experience Tier 2		3
CORE: Societal and Cultural Knowledge Tier 1		3

Apply for B.S./M.S. Program

Hours **15**

Year 4**Fall**

Select one of the following: 3-4

BIOL 390	Molecular Biology Laboratory	
BIOL 565	Exploring Proteins (BS+MS credit; Fall only)	
or CHEM 465	or Special Topics in Biochemistry	
COMP 353	Database Programming	
or COMP 379	or Machine Learning	

CAS Elective	3
CORE: Societal and Cultural Knowledge Tier 2	3
CORE: Artistic Knowledge and Experience	3

Hours **12-13**

Spring

BIOL 501	Bioinformatics Seminar ⁵	1
STAT 437	Quantitative Bioinformatics (BS+MS credit; Fall only) ³	3
COMP 483	Computational Biology (BS+MS; Spring only) ³	4
CAS Elective		3
Select one of the following (Undergraduate Research Capstone):		1
BIOL 397	Bioinformatics Survey	
BIOL 398	Bioinformatics Internship	
BIOL 399	Bioinformatics Research	

Hours **12**

Year 5**Fall**

Bioinformatics Elective	^{5,6}	3
Bioinformatics Elective	^{5,6}	3
BIOL 498	Bioinformatics Internship ⁵	1
BIOL 500	Advanced Bioinformatics ⁵	3

Hours **10**

Spring

Bioinformatics Elective ^{5,6}	3
Bioinformatics Elective ^{5,6}	3
Bioinformatics Elective ^{5,6}	3

Hours **9**

Total Hours **134-135**

¹ This course is required to meet the GPA requirements for admission into the Bioinformatics ABM program.

² Courses that could be applied towards both the B.S. and M.S. degrees.

³ Alternatively, CHEM 465 Special Topics in Biochemistry can be taken [Spring odd years only]

⁴ Courses required for the MS degree total 30 credit hours.

⁵ If Bioinformatics is taken at the undergraduate level (BIOL 388 Bioinformatics), at least one of the *Bioinformatics Electives* must be in **Biology**.

Suggested Sequence of Courses - Thesis Track

Course	Title	Hours
Year 1		
Fall		
BIOL 101	General Biology I	3
CHEM 160	Chemical Structure and Properties	3
MATH 131	Applied Calculus I	3
or MATH 161	or Calculus I	
CORE: College Writing Seminar		3
CORE: Theology and Religious Studies Tier 1		3
Hours		15

Spring

COMP 141	Introduction to Computing Tools and Techniques	3
CHEM 180	Chemical Reactivity I	3
MATH 132	Applied Calculus II	3
or MATH 162	or Calculus II	
CORE: Ethics		3
CORE: Theology and Religious Studies Tier 2		3
Hours		15

Year 2**Fall**

BIOL 282	Genetics	3
BIOL 283	Genetics Laboratory	1
CHEM 240	Chemical Reactivity II	3
MATH 215	Object-Oriented Programming with Mathematics ¹	3
CORE: Historical Knowledge Tier 1		3
CORE: Philosophical Knowledge Tier 1		3

Hours **16**

Spring

COMP 231	Data Structures & Algorithms for Informatics	3
CHEM 260	Quantitative Methods in Chemistry	3
CAS Elective		3
CORE: Historical Knowledge Tier 2		3

CORE: Philosophical Knowledge Tier 2	3
Hours	15
Year 3	
Fall	
BIOL 388 Bioinformatics ¹	3
CHEM 361 Principles of Biochemistry ¹	3
Select one of the following (Undergraduate Research Capstone): ¹	1
BIOI 397 Bioinformatics Survey	
BIOI 398 Bioinformatics Internship	
BIOI 399 Bioinformatics Research	
CAS Elective	3
CAS Language Requirement 1	3
CORE: Literary Knowledge & Experience Tier 1	3
Hours	16
Spring	
STAT 335 Introduction to Biostatistics ¹	3
BIOL 387 Genomics (Spring only) ^{1, 2}	3
CAS Language Requirement 2	3
CORE: Literary Knowledge & Experience Tier 2	3
CORE: Societal and Cultural Knowledge Tier 1	3
Apply for B.S./M.S. Program	
Hours	15
Year 4	
Fall	
UNIV 370 Responsible Conduct in Research and Scholarship ³	0
BIOI 494 Bioinformatics Research Design ³	1
Select one of the following:	3-4
BIOL 390 Molecular Biology Laboratory	
BIOI 565 Exploring Proteins ^{4, 5}	
or CHEM 465 or Special Topics in Biochemistry	
COMP 353 Database Programming	
or COMP 379 or Machine Learning	
CAS Elective	3
CORE: Societal and Cultural Knowledge Tier 2	3
Hours	10-11
Spring	
BIOI 501 Bioinformatics Seminar ³	1
COMP 483 Computational Biology ⁴	4
STAT 437 Quantitative Bioinformatics ⁴	3
CAS Elective	3
CORE: Artistic Knowledge and Experience	3
Hours	14
Year 5	
Fall	
BIOI 499 Bioinformatics Research ³	8
BIOI 500 Advanced Bioinformatics ³	3
Hours	11
Spring	
Bioinformatics Elective ^{3, 6}	3
Bioinformatics Elective ^{3, 6}	3

BIOI 595	Thesis Supervision ³	1
Hours		7
Total Hours		134-135

¹ This course is required to meet the GPA requirements for admission into the Bioinformatics ABM program.

² Alternatively, BIOL 392 Metagenomics can be taken [Fall only]

³ Courses required of the M.S. degree, totaling 30 credit hours.

⁴ Courses which could be applied towards both the B.S. and M.S. degrees.

⁵ Alternatively CHEM 465 Special Topics in Biochemistry can be taken [Spring odd years only]

⁶ If Bioinformatics is taken at the undergraduate level (BIOL 388 Bioinformatics), at least one of the *Bioinformatics Electives* must be in **Biology**.

Rules for taking MS courses in senior year:

- A maximum of 15 Graduate-level credit hours can be taken during the undergraduate program.
- Included in these 15 credit hours may be up to three designated courses that may count as Shared Credits for the BS as well as the MS degree (formerly known as double dipping). Designated courses are listed at the bottom of this curriculum. The three recommended Shared Credits are included in the course list.
- Graduate-level credit hours that are not Shared Credits will count toward your MS degree only.

The following courses are required for the Bioinformatics ABM programs (BIOI-BS/BIOIMS). Two tracks are offered: a thesis track and a non-thesis track. While most fundamental courses are required for both tracks, some track-specific Graduate-level courses are listed under the respective thesis track and non-thesis track headers.

Guidelines for Accelerated Bachelor's/Master's Programs

Terms

- **Accelerated Bachelor's/Master's programs:** In this type of program, students share limited credits between their undergraduate and graduate degrees to facilitate completion of both degrees.
- **Shared credits:** Graduate level credit hours taken during the undergraduate program and then applied towards graduate program requirements will be referred to as shared credits.

Admission Requirements

Accelerated Bachelor's/Master's programs are designed to enhance opportunities for advanced training for Loyola's undergraduates. Admission to these programs must be competitive and will depend upon a positive review of credentials by the program's admissions committee. Accordingly, the admission requirements for these programs may be higher than those required if the master's degree were pursued entirely after the receipt of a bachelor's degree. That is, programs may choose to have more stringent admissions requirements in addition to those minimal requirements below.

Requirements:

- Declared appropriate undergraduate major,
- By the time students begin taking graduate courses as an undergraduate, the student has completed approximately 90 credit

hours, or the credit hours required in a program that is accredited by a specialty organization,¹

- A minimum cumulative GPA for coursework at Loyola that is at or above the program-specific requirements, a minimum major GPA that is at or above the program-specific requirements, and/or appropriate designated coursework for evaluation of student readiness in their discipline.²

Students not eligible for the Accelerated Bachelor's/Master's program (e.g., students who have not declared the appropriate undergraduate major) may apply to the master's program through the regular admissions process. Students enrolled in an Accelerated Bachelor's/Master's program who choose not to continue to the master's degree program upon completion of the bachelor's degree will face no consequences.³

Ideally, a student will apply for admission (or confirm interest in proceeding towards the graduate degree in opt-out programs) as they approach 90 credit hours. Programs are encouraged to begin advising students early in their major so that they are aware of the program and, if interested, can complete their bachelor's degree requirements in a way that facilitates completion of the program. Once admitted as an undergraduate, Program Directors should ensure that students are enrolled using the plan code associated with the Accelerated Bachelor's/Master's program. Using the plan code associated with the Accelerated Bachelor's/Master's program will ensure that students may be easily identified as they move through the program. Students will not officially matriculate into the master's degree program and be labeled as a graduate student by the university, with accompanying changes to tuition and Financial Aid (see below), until the undergraduate degree has been awarded. Once admitted to the graduate program, students must meet the academic standing requirements of their graduate program as they complete the program curriculum.

¹ Programs that have specialized accreditation will adhere to the admissions criteria provided by, or approved by, their specialized accreditors.

² The program will identify appropriate indicators of student readiness for graduate coursework (e.g., high-level performance in 300 level courses). Recognizing differences between how majors are designed, we do not specify a blanket requirement.

³ If students choose not to enroll in the Accelerated Bachelor's/Master's program, they still must complete all of the standard requirements associated with the undergraduate degree (e.g., a capstone).

For more information on Admissions requirements, visit here (<https://gpem.luc.edu/portal/admission/?tab=home>).

Curriculum

Level and progression of courses. The Accelerated Bachelor's/Master's programs are designed to be competitive and attractive to our most capable students. Students admitted to Accelerated Bachelor's/Master's programs should be capable of meeting graduate level learning outcomes. Following guidance from the Higher Learning Commission, only courses taken at the 400 level or higher (including 300/400 level courses taken at the 400 level) will count toward the graduate program.^{1,2}

Up to 50% of the total graduate level credit hours, required in the graduate program, may come from 300/400 level courses where the student is enrolled in the 400 level of the course. Further, at least 50% of the credit hours for the graduate program must come from courses that are designed for and restricted to graduate students who have been admitted to a graduate program at Loyola (e.g., enrolled in plan code that

indicates the Accelerated Bachelor's/Master's program, typically ending with the letter "D").³

In general, graduate level coursework should not be taken prior to admission into the Accelerated Bachelor's/Master's program. Exceptions may be granted for professional programs where curriculum for the Accelerated Bachelor's/Master's program is designed to begin earlier. On the recommendation of the program's Graduate Director, students may take one of their graduate level courses before they are admitted to the Accelerated Bachelors/Master's program if they have advanced abilities in their discipline and course offerings warrant such an exception.⁴ Undergraduate degree requirements outside of the major are in no way impacted by admission to an Accelerated Bachelor's/Master's program.⁵

Shared credits. Undergraduate courses (i.e., courses offered at the 300 level or below) cannot be counted as shared credits nor count towards the master's degree. Up to 50% of the total graduate level credit hours, required in the graduate program, may be counted in meeting both the undergraduate and graduate degree requirements. Of those shared credits, students in an Accelerated Bachelor's/Master's program should begin their graduate program with the standard introductory course(s) for the program whenever possible. So that students may progress through the Accelerated Bachelor's/Master's program in a timely manner, undergraduate programs are encouraged to design their curriculum such that a student can complete some required graduate credit hours while completing the undergraduate degree. For instance, some of the graduate curriculum should also satisfy electives for the undergraduate major.

The program's Graduate Director will designate credit hours to be shared through the advising form and master's degree conferral review process. Shared credit hours will not be marked on the undergraduate record as having a special status in the undergraduate program. They will be included in the student's undergraduate earned hours and GPA. Graduate credit hours taken during the undergraduate program will not be included in the graduate GPA calculation.

¹ If students wish to transfer credits from another university to Loyola University Chicago, the program's Graduate director will review the relevant syllabus(es) to determine whether it meets the criteria for a 400 level course or higher.

² Programs with specialized accreditation requirements that allow programs to offer graduate curriculum to undergraduate students will conform to those specialized accreditation requirements.

³ In rare cases, the Graduate Director may authorize enrollment in a 400-level course for a highly qualified and highly motivated undergraduate, ensuring that the undergraduate's exceptional participation in the graduate class will not diminish in any way the experience of the graduate students regularly enrolled.

⁴ For example, if a particular course is only offered once every 2-3 years, and a student has demonstrated the necessary ability to be successful, the Graduate Director may allow a student to take a graduate level course to be shared prior to the student being formally admitted to the graduate program. See, also, footnote 3.

⁵ Students should not, for example, attempt to negotiate themselves out of a writing intensive requirement on the basis of admission to a graduate program.

Graduation

Degrees are awarded sequentially. All details of undergraduate commencement are handled in the ordinary way as for all students in the School/College/Institute. Once in the graduate program, students abide by the graduation deadlines set forth by the graduate program. Students

in these programs must be continuously enrolled from undergraduate to graduate degree program unless given explicit permission by their program for a gap year or approved leave of absence. In offering the option of an Accelerated Bachelor's/Master's program, the university is making possible the acceleration of a student's graduate degree completion. It should be understood that students may not request deferral of their matriculation into the Master's degree program. If students would like to delay their graduate studies after earning the undergraduate degree, they may apply for admission to the traditional master's degree program. Any application of graduate credit earned while in the undergraduate program is subject to the policies of the graduate degree granting school.

Learning Outcomes

Loyola's Bioinformatics ABM Programs will prepare you with the following:

- technical skills at the interface of biology, computer science, chemistry, and statistics;
- biological and chemical laboratory techniques;
- computer programming capabilities;
- statistical techniques to analyze results from laboratory experiments and computer outputs
- an understanding of critical problems, proposed solutions, and future challenges of the bioinformatics field; and
- the ability to conduct bioinformatics studies in the industry and the research environment.