BIOINFORMATICS, BACHELOR OF SCIENCE (B.S.) WITH A CONCENTRATION IN QUANTITATIVE/STATISTICAL SCIENCES

This bioinformatics program consists of a core curriculum that provides immersion in the field of bioinformatics as well as foundational courses in biology, chemistry, computer science and statistics. The bachelor's program in bioinformatics requires breadth of training via the VCU ConnectED general education requirements, a bioinformatics core with ancillary scientific course work and focused training in the areas of biological/genomic sciences, computational sciences or quantitative/statistical sciences through the concentration-specific courses.

Students wishing to pursue the bioinformatics major must apply for admission into the program. High school seniors as well as students transferring to VCU should follow the regular VCU admissions process and deadlines, being sure to indicate clearly in their application that they wish to apply to the bioinformatics program. Continuing VCU students wishing to apply to the program may contact the bioinformatics academic adviser at (804) 828-0825.

Transfer students and continuing VCU students with at least 15 college credits should present a suggested college GPA of 3.0 including relevant course work in science, math or computer science.

Learning outcomes

Upon completing this program, students will know and know how to do the following:

- Present scientific results, both orally and in writing, in a way that makes clear to an appropriate target audience the distinction between what is known (and how) and what is merely suspected between an observation and a conclusion in a way that tells a compelling story
- Will have demonstrated fundamental knowledge of the basic concepts of biology (particularly molecular biology), the physical sciences, mathematics, statistics and computational science and the ability to apply that knowledge within the context of bioinformatics
- Will have demonstrated an ability to identify and analyze bioinformatics problems and strategies to solve said problems
- Will possess an appropriate level of technical knowledge and ability necessary to address a scientific problem by exploiting biological software and datasets and creating simple bioinformatics tools
- Will have demonstrated an ability to identify and access relevant scientific literature and draw from it in a meaningful and critical manner

Special requirements

A minimum grade of C in the following courses is required for enrollment in all courses for which they are prerequisites and to successfully complete the B.S. in Bioinformatics with a concentration in quantitative/statistical sciences:

Course	Title	Hours
BIOL 151	Introduction to Biological Sciences I	3
BIOL 152	Introduction to Biological Sciences II	3
BIOL 300	Cellular and Molecular Biology	3
BNFO 101	Introduction to Scientific Computing	1
BNFO 201	Computing Skills and Concepts for Bioinformatics	3
BNFO 251	Phage Discovery I	2
BNFO 252	Phage Discovery II	2
BNFO 301	Introduction to Bioinformatics	3
BNFO 411	Ethical Issues in Life Sciences	2
BNFO 420	Applications in Bioinformatics	3
CHEM 101	General Chemistry I	3
CHEZ 101	General Chemistry Laboratory I	1
MATH 200	Calculus with Analytic Geometry I	4
MATH 201	Calculus with Analytic Geometry II	4

Degree requirements for Bioinformatics, Bachelor of Science (B.S.) with a concentration in quantitative/statistical sciences

Course	Title	Hours
General education (https://bulletin.vcu.edu/undergraduate/undergraduate-study/general-education-curriculum/)		
Select 30 credits of general education courses in consultation with an adviser. [1]		30
Major requirements		
• Major core requirements		
BIOL 152	Introduction to Biological Sciences II	3
BIOL 300	Cellular and Molecular Biology	3
BIOL 310	Genetics	3
BNFO 101	Introduction to Scientific Computing	1
BNFO 201	Computing Skills and Concepts for Bioinformatics	3
BNFO 251	Phage Discovery I	2
BNFO 252	Phage Discovery II	2
BNFO 301	Introduction to Bioinformatics	3
BNFO 411	Ethical Issues in Life Sciences	2
BNFO 420	Applications in Bioinformatics	3
CHEM 102	General Chemistry II	3
CHEZ 101	General Chemistry Laboratory I	1
CHEZ 102	General Chemistry Laboratory II	1
CMSC 255	Object-oriented Programming	4
STAT 321	Introduction to Statistical Computing for Data Science	3
• Concentration requirements		
MATH 201	Calculus with Analytic Geometry II	4
MATH 307	Multivariate Calculus	4
MATH 310	Linear Algebra	3
STAT 314	Applications of Statistics	4
Select concentration electives from list below.		9
Ancillary requirements [1]		

BIOL 151	Introduction to Biological Sciences I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	3
CHEM 101	General Chemistry I (satisfies general education AOI for scientific and logical reasoning)	3
MATH 200	Calculus with Analytic Geometry I	4
PHYS 207	University Physics I (either course satisfies general education AOI for scientific and logical reasoning)	4-5
or PHYS 201	General Physics I	
STAT 212	Concepts of Statistics (satisfies general education quantitative foundations)	3
Open electives		
Select any course.		23-24
Total Hours		**120**

[1]

The ancillary courses fulfill 12 of the required 30 credits of general education, including fulfillment of the quantitative foundations requirement, the natural sciences breadth of knowledge requirement and the maximum allowable nine credits of scientific and logical reasoning area of inquiry.

The minimum number of credit hours required for this degree is 120.

Concentration electives

Course	Title	Hours
BIOL 318	Evolution	3
BIOS 524	Biostatistical Computing	3
BNFO/MATH 380	Introduction to Mathematical Biology	4
BNFO 391	Special Topics in Bioinformatics (variable) [1,2]	1-4
BNFO 393	Special Topics in Bioinformatics (variable) [1,2]	1-4
BNFO 491	Special Topics in Bioinformatics (variable) [1,2]	1-4
BNFO 492	Independent Study (variable) [1]	1-4
BNFO 493	Special Topics in Bioinformatics (variable) [1,2]	1-4
BNFO 496	Undergraduate Teaching Assistantship in Bioinformatics (variable) [1]	1-2
BNFO 497	Research and Thesis (variable) [1]	1-4
BNFO/BIOL 540	Fundamentals of Molecular Genetics	3
BNFO/BIOL 541	Laboratory in Molecular Genetics	2
BNFO 591	Special Topics in Bioinformatics (variable) [1,2]	1-4
BNFO 593	Special Topics in Bioinformatics (variable) [1,2]	1-4
CMSC 256	Introduction to Data Structures	4
CMSC 302	Introduction to Discrete Structures	3
MATH 211	Mathematical Structures	3
MATH 356	Graphs and Algorithms	3
STAT 309	Introduction to Probability Theory	3
STAT 403	Introduction to Stochastic Processes	3
STAT 421	Statistical Computing for Machine Learning and Artificial Intelligence	3
STAT 425	Multivariate Statistics	3
STAT 441	Applied Statistics for Engineers and Scientists	3

[1]

May be taken only with adviser's permission

[2]

No more than 8 combined credits of BNFO 391, BNFO 393, BNFO 491, BNFO 493, BNFO 591, and BNFO 593 may apply toward concentration elective requirements.

What follows is a sample plan that meets the prescribed requirements within a four-year course of study at VCU. Please contact your adviser before beginning course work toward a degree.

Recommended course sequence/plan of study

Freshman year

Fall semester		**Hours**
BIOL 151	Introduction to Biological Sciences I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	3
BNFO 251	Phage Discovery I	2
CHEM 101	General Chemistry I (satisfies general education AOI for scientific and logical reasoning)	3
CHEZ 101	General Chemistry Laboratory I (satisfies general education AOI for scientific and logical reasoning)	1
UNIV 111 Play course video for Introduction to Focused Inquiry: Investigation and Communication	Introduction to Focused Inquiry: Investigation and Communication (satisfies general education UNIV foundations)	3
General education course		3
	Term Hours:	**15**
Spring semester		
BIOL 152	Introduction to Biological Sciences II	3
BNFO 101	Introduction to Scientific Computing	1
BNFO 252	Phage Discovery II	2
CHEM 102	General Chemistry II	3
UNIV 112 Play course video for Focused Inquiry II	Focused Inquiry II (satisfies general education UNIV foundations)	3
General education course		3
	Term Hours:	**15**

Sophomore year

Fall semester

BIOL 300	Cellular and Molecular Biology	3
BNFO 201	Computing Skills and Concepts for Bioinformatics	3
CHEZ 102	General Chemistry Laboratory II	1
STAT 212	Concepts of Statistics (satisfies general education quantitative foundations)	3
UNIV 200	Advanced Focused Inquiry: Literacies, Research and Communication (satisfies general education UNIV foundations)	3
General education course		3
	Term Hours:	**16**
Spring semester		
BNFO 301	Introduction to Bioinformatics	3
CMSC 255	Object-oriented Programming	4
MATH 200	Calculus with Analytic Geometry I	4
Open electives		3
	Term Hours:	**14**
Junior year		
Fall semester		
BIOL 310	Genetics	3
BNFO 411	Ethical Issues in Life Sciences	2
MATH 201	Calculus with Analytic Geometry II	4
STAT 314	Applications of Statistics	4
Open elective		2
	Term Hours:	**15**
Spring semester		
MATH 307	Multivariate Calculus	4
PHYS 207	University Physics I (satisfies general education AOI for scientific and logical reasoning)	5
STAT 321	Introduction to Statistical Computing for Data Science	3
Concentration elective		3
	Term Hours:	**15**
Senior year		
Fall semester		
MATH 310	Linear Algebra	3
Concentration elective		3
Open electives		9
	Term Hours:	**15**
Spring semester		
BNFO 420	Applications in Bioinformatics	3
Concentration elective		3
Open electives		9
	Term Hours:	**15**
	Total Hours:	**120**

The minimum number of credit hours required for this degree is 120.

Accelerated B.S. and M.S.

The accelerated B.S. and M.S. program allows qualified students to earn both the B.S. and M.S. in Bioinformatics in a minimum of five years by completing approved graduate courses during the senior year of their undergraduate program. Students in the program may count up to 12 hours of graduate courses toward both the B.S. and M.S. degrees. Thus, the two degrees may be earned with a minimum of 142 credits rather than the 154 credits necessary if the two degrees are pursued separately.

Students holding these degrees will have a head start for pursuing careers in industry or continuing in an academic setting. The M.S. degree provides two tracks: (1) a thesis track with formal research experience and (2) a nonthesis (professional science master's) track combining business skills with an externship experience. This degree can lead to expanded job opportunities, greater potential for job advancement and higher starting salaries.

Entrance to the accelerated program

Interested undergraduate students should consult with their adviser as early as possible to receive specific information about the accelerated program, determine academic eligibility and submit (no later than two semesters prior to graduating with a baccalaureate degree, that is, before the end of the spring semester of their junior year) an Accelerated Program Declaration Form to be approved by the graduate program director. Limited spaces may be available in the accelerated program. Academically qualified students may not receive approval if capacity has been reached.

Minimum qualifications for entrance to this accelerated program include completion of 90 undergraduate credit hours; an overall GPA of 3.0; and a GPA of 3.0 in bioinformatics degree course work. Applicants should have completed a substantial amount of course work toward the B.S. degree and maintained a strong academic record. Students who are interested in the accelerated program should consult with the program director to the M.S. in Bioinformatics program during their junior year after they have completed 75 credits and before they have completed 90 credits toward the B.S. degree. Applicants to this accelerated program must have junior or senior status in VCU's B.S. in Bioinformatics program. Successful applicants would enter the accelerated program in the first semester of their senior year.

Once enrolled in the accelerated program, students must meet the standards of performance applicable to graduate students as described in the "**Satisfactory academic progress**" section of the Graduate Bulletin, including maintaining a 3.0 GPA. Guidance to students admitted to the accelerated program is provided by both the undergraduate bioinformatics adviser and the program director of the bioinformatics graduate program.

Admission to the graduate program

Entrance to the accelerated program enables the student to take the approved shared courses that will apply to the undergraduate and graduate degrees. However, entry into an accelerated program via an approved Accelerated Program Declaration Form does not constitute application or admission into the graduate program. Admission to the graduate program requires a separate step that occurs through a formal application to the master's program, which is submitted through Graduate Admissions no later than a semester prior to graduation with the baccalaureate degree, that is, before the end of the first semester of the senior year. In order to continue pursuing the master's degree after the baccalaureate degree is conferred, accelerated students must follow the admission to graduate study requirements outlined in the VCU Bulletin. Two reference letters (at least one from a bioinformatics faculty member) must accompany the application.

Degree requirements

The Bachelor of Science in Bioinformatics degree will be awarded upon completion of a minimum of 120 credits and the satisfactory completion of all undergraduate degree requirements as stated in the Undergraduate Bulletin.

A maximum of 12 graduate credits may be taken prior to completion of the baccalaureate degree. These graduate credits may substitute for bioinformatics requirements for the undergraduate degree, and are planned in consultation with the undergraduate academic adviser and the graduate program director. These courses are shared credits with the graduate program, meaning that they will be applied to both undergraduate and graduate degree requirements. For best alignment of these credits, students must plan ahead.

Examples of bioinformatics degree courses that may be taken as an undergraduate, once a student is admitted to the program, are:

Course	Title	Hours
BIOS 543	Graduate Research Methods I	3
BNFO 540	Fundamentals of Molecular Genetics	3
BNFO 541	Laboratory in Molecular Genetics	2
BNFO 592	Independent Study	1-9
BNFO 620	Bioinformatics Practicum	3
BNFO 621	Business and Entrepreneurship Essentials for Life Scientists	3
BNFO 653	Advanced Molecular Genetics: Bioinformatics	3
BNFO 692	Independent Study	1-9
CMSC 508	Database Theory	3

Recommended course sequence/plan of study

What follows is the recommended plan of study for students interested in the accelerated program beginning in the fall of the junior year prior to admission to the accelerated program in the senior year.

Course	Title	Hours
Junior year		
Fall semester		
BIOL 300	Cellular and Molecular Biology	3
BNFO 411	Ethical Issues in Life Sciences	2
Required B.S. course work		10
Term Hours:		15
Spring semester		
BNFO 541	Laboratory in Molecular Genetics	2
PHYS 207	University Physics I	5
STAT 321	Introduction to Statistical Computing for Data Science	3
Required B.S. course work		5
Term Hours:		15
Senior year		
Fall semester		
BNFO 540	Fundamentals of Molecular Genetics	3
CMSC 256	Introduction to Data Structures	4
Required B.S. course work		8
Term Hours:		15
Spring semester		
Required B.S. course work		5
BNFO 601	Integrated Bioinformatics	4
BNFO 620	Bioinformatics Practicum	3
BNFO 621	Business and Entrepreneurship Essentials for Life Scientists	3
Term Hours:		15
Fifth year		
Fall semester		
BNFO 531	Quantitative Methods in Bioinformatics	3
BNFO 690	Seminars in Bioinformatics	1
OVPR 601	Scientific Integrity	1
Graduate electives (500 and 600 level) [1]		5
Term Hours:		11
Spring semester		
BNFO 653	Advanced Molecular Genetics: Bioinformatics	3
BNFO 700	Externship in Bioinformatics	2
Graduate electives (500 and 600 level) [1]		6
Term Hours:		11

[1]

For example: 500-level (or higher) BIOL, BIOC, BIOS, BNFO, CMSC, ENVS, HGEN, LFSC, STAT courses

Students interested in the accelerated B.S. and M.S. program can contact the individuals listed below who will explain the program and coordinate the curriculum.

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Graduate program director
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