

INTEGRATIVE LIFE SCIENCES, DOCTOR OF PHILOSOPHY (PH.D.) [VCU LIFE SCIENCES]

Program mission

The Ph.D. in Integrative Life Sciences is designed for students who want to conduct research that is integrative across multiple disciplines and that takes a systems approach to emerging research questions across the many fields that comprise the life sciences. Students may opt to work with faculty members from any department, center or institute across VCU campuses. The program provides the opportunity to conduct interdisciplinary research at multiple scales of study from the molecular to ecosystem levels with an emphasis on the concepts of systems biology and biological complexity.

Program goals

- 1. Interdisciplinary knowledge and skills:** The core curriculum of the ILS program will effectively assist students in gaining understanding of modern systems biology along with training in the interdisciplinary skills and knowledge increasingly required for doing effective research in the life sciences. It will also foster progressive development of a mastery of the current state of the research in students' areas of interest as they seek to identify key focus areas for their integrative research.
- 2. Research skills:** The mentored research component of the program, building on the core curriculum and interdisciplinary elective course work, will foster development of an ability to synthesize this learning and identify key focus areas for integrative research. It will support students as they learn how to design, implement and interpret interdisciplinary experimental approaches that will best address their research questions.
- 3. Communication skills:** Students in the program will develop skills in both written and oral communication of life science knowledge, experimental design, results and interpretation to a variety of potential audiences.

Student learning outcomes

- 1. Oral communication skills:** The candidate will demonstrate the achievement of an appropriate level of oral communication skills with respect to the content, organization, logical flow, presentation and appropriate use of language incorporating the use of visual aids, as measured by rubric.
- 2. Written communication skills:** The candidate will demonstrate the achievement of an appropriate level of written communication skill with respect to grammar, syntax, spelling and use of vocabulary to effectively present information including the use of figures, tables and citations, as measured by rubric.
- 3. Experimental design:** The candidate will demonstrate the achievement of an appropriate level of competence in the ability to appraise, modify, and/or create and implement experimental protocols and to design and develop experiments, as measured by rubric.
- 4. Problem-solving skills:** The candidate will demonstrate an appropriate level of skill in the identification and selection of meaningful problems to be addressed in bioscience research, including the ability to defend said identifications and to design and

develop appropriate methods to solve said problems, as measured by rubric.

- 5. Integrated knowledge:** The candidate will demonstrate an appropriate level of knowledge of the life sciences and a more detailed understanding of the disciplines most pertinent to their own interdisciplinary research areas, including an appropriate familiarity with the research literature and the ability to evaluate and critique publications, as measured by rubric.

VCU Graduate Bulletin, VCU Graduate School and general academic policies and regulations for all graduate students in all graduate programs

The VCU Graduate Bulletin website documents the official admission and academic rules and regulations that govern graduate education for all graduate programs at the university. These policies are established by the graduate faculty of the university through their elected representatives to the University Graduate Council.

It is the responsibility of all graduate students, both on- and off-campus, to be familiar with the VCU Graduate Bulletin as well as the **Graduate School website** and academic regulations in individual school and department publications and on program websites. However, in all cases, the official policies and procedures of the University Graduate Council, as published on the VCU Graduate Bulletin and Graduate School websites, take precedence over individual program policies and guidelines.

Visit the Graduate study section for additional information on academic regulations for graduate students.

Degree candidacy requirements

A graduate student admitted to a program or concentration requiring a final research project, work of art, thesis or dissertation, must qualify for continuing master's or doctoral status according to the degree candidacy requirements of the student's graduate program. Admission to degree candidacy, if applicable, is a formal statement by the graduate student's faculty regarding the student's academic achievements and the student's readiness to proceed to the final research phase of the degree program.

Graduate students and program directors should refer to the following degree candidacy policy as published in the VCU Graduate Bulletin for complete information and instructions.

Visit the Graduate study section for additional information on degree candidacy requirements.

Graduation requirements

As graduate students approach the end of their academic programs and the final semester of matriculation, they must make formal application to graduate. No degrees will be conferred until the application to graduate has been finalized.

Graduate students and program directors should refer to the following graduation requirements as published in the Graduate Bulletin for a complete list of instructions and a graduation checklist.

Visit the Graduate study section for additional information on graduation requirements.

Apply online at graduate.admissions.vcu.edu (<http://graduate.admissions.vcu.edu>).

Admission requirements

Degree:	Semester(s) of entry:	Deadline dates:	Test requirements:
Ph.D.	Fall (preferred)	Jan. 10	GRE
			International students require TOEFL

Note: All application components must be received by Jan. 10 to be competitive.

In addition to the general admission requirements of the VCU Graduate School (<http://bulletin.vcu.edu/graduate/study/admission-graduate-study/admission-requirements>), the Ph.D. in Integrative Life Sciences program requires graduation from an accredited college or university or its equivalent with a degree that is preparative for graduate-level study in the life sciences. Applicants should have a minimum GPA of 3.0 on a 4.0 scale, and scores on the Graduate Record Examination should exceed the 50th percentile in each category. For international applicants, satisfactory scores from a standardized test, such as the TOEFL (above 100), must be submitted along with external evaluation of undergraduate transcripts from nondomestic educational institutions (see Graduate Admissions website (<http://graduate.admissions.vcu.edu/apply>) for further details).

Letters of recommendation from three present or former professors, advisers or mentors qualified to evaluate the applicant's ability to engage in graduate study in the life sciences are required, as is a written statement describing the applicant's research interests, motivation, research experience, education and goals for pursuing graduate study in this particular program, and preferred research adviser(s), official transcripts from all past postsecondary educational institutions, official GRE scores, and current curriculum vita or resume. Applicants are **strongly** encouraged to contact potential research advisers prior to submitting application materials and to identify potential research advisers in their personal statements.

Students accepted into the program with a 3.4 and higher undergraduate GPA and/or experience of success in graduate course work will be provided with a stipend and tuition and fees for the first year of matriculation. Following satisfactory progress during the first year and the availability of funds, a second year of funding (stipend, tuition and fees) is available. Preference is given to applicants with preidentified research advisers.

Degree requirements

In addition to general VCU Graduate School graduation requirements (<http://bulletin.vcu.edu/graduate/study/general-academic-regulations-graduate-students/graduation-requirements>), students are required to complete course work in core and elective courses and to conduct significant research. All work toward the degree must be completed within eight years of the first enrollment.

- Credit-hour requirements:** Students in the program are required to earn a minimum of 64 graduate-level credit hours. At least one-half of the graduate credit hours presented for graduation must be at the 600 level or higher.
- Grade requirement:** Degree applicants must achieve an overall GPA of 3.0 (B) with a grade of C in no more than two courses. The GPA

for graduation is based on all graduate courses attempted after acceptance into the program.

- Transfer credit:** Graduate-level VCU course work taken as a nondegree-seeking student or in a previous graduate matriculation for which a degree was never awarded may be evaluated to determine whether it can be used to fulfill degree requirements of this program in accordance with the VCU Graduate School transfer policy (<http://bulletin.vcu.edu/graduate/study/general-academic-regulations-graduate-students/transfer-credit>). A maximum of six credit hours earned at another institution can be accepted for transfer into the program if not previously applied toward another degree. A minimum grade of B is required for credit hours transferred.
- Research adviser and committee:** Students should select a research adviser prior to matriculation, but no later than the end of the first semester. The research adviser may be chosen from among the many graduate faculty members associated with this program from either VCU campus.

Students are required to form a research advisory committee that is headed by the research adviser and that consists of a minimum of five members of the VCU graduate faculty. Individuals who are not graduate faculty members (i.e., individuals from another institution or industry) must apply to the dean of the Graduate School for temporary affiliate graduate faculty appointment. The significant areas of the student's research focus should be represented by the members of the research advisory committee. At least two members of the committee shall have primary appointments in departments other than that of the research adviser, with one of those members being integrally associated with the student's research to foster the interdisciplinary intent of this degree program. Students should form their committees no later than the end of the second semester of study.

- Written and oral examinations:** Before admission to degree candidacy for the Ph.D. degree, students must successfully complete a comprehensive written examination and an oral examination. The student's research advisory committee will administer both exams. Students should take the written exam upon completion of all required didactic course work, usually no later than the end of the second year of study. It will focus on material covered in core and selected elective courses as well as fundamental knowledge relevant to the student's research field. Upon successful completion of the written examination and submission and acceptance of a research proposal, students will take an oral examination that includes a defense of the proposed research project and other subject areas deemed appropriate by the committee. Students may retake the written and oral examinations only once. Written evaluations of the written examination, written dissertation proposal and oral dissertation proposal defense will be completed by research advisory committee members and provided to the chair of the research advisory committee to discuss with the student and to the program director for program assessment.
- Dissertation research:** The dissertation research project should represent a significant contribution to the body of knowledge in its field and should be deemed suitable for publication in refereed journals. The emphasis of the research conducted by students in this program should be on interdisciplinary research, incorporating two or more disciplines and with a systems approach. Research projects may take advantage of the many research opportunities across the life sciences on both campuses. Projects may encompass multiple scales of study from molecular to ecosystem levels. Students shall prepare a written dissertation describing the completed research

using the format approved by the Graduate School. An oral defense of the dissertation, under the direction of the research advisory committee and open to all faculty members, also is required. Written evaluations of the dissertation and the oral defense of the dissertation will be completed by research advisory committee members and provided to the chair of the research advisory committee to discuss with the student and to the program director for program assessment. Upon successful completion of all degree requirements, students will graduate with the Ph.D. in Integrative Life Sciences.

Curriculum requirements

A minimum total of 64 graduate credit hours is required and is distributed as follows:

Core courses

LFSC 510/BIOL 545	Biological Complexity	3
LFSC 630	Integrative Life Sciences Research	2
Complete four semesters		4

LFSC 690	Research Seminar in Integrative Life Sciences (one credit hour)	
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Scientific integrity

Select one of the following:		1
OVRP 601	Scientific Integrity	
OVRP 602	Responsible Scientific Conduct	
OVRP 603	Responsible Conduct of Research ¹	

Technologies course (recommended options; choice depends on student's specialty)

Select one of the following:		2
ANAT 615	Techniques in Neuroscience and Cell Biology	
BNFO/BIOL 541	Laboratory in Molecular Genetics	
BNFO 650	Sequence Analysis in Biological Systems	
ENVS 602	Environmental Technology	
MICR 607	Techniques in Molecular Biology and Genetics	
MICR/BNFO 653	Advanced Molecular Genetics: Bioinformatics	

Advanced statistics, advanced mathematics or experimental design course

Select one of the following: ^{2,3}		3
BIOL 606	Quantitative Ecology	
BIOS 524	Biostatistical Computing	
BIOS 572	Analysis of Biomedical Data I	
BNFO/BIOL 601	Integrated Bioinformatics	
ENVS 603	Environmental Research Methods	
LFSC 610	Analytical Methods in Biocomplexity Analysis	
MATH 591	Topics in Mathematics (mathematical biology)	
STAT 544 or BIOS 544	Statistical Methods II Graduate Research Methods II	
STAT 623	Discrete Multivariate Analysis	
STAT 643	Applied Linear Regression	

Other courses based on approval of research advisory committee

Elective courses		
Select nine credit hours of the following: ^{4,5}		9
500-level or higher courses in ANAT, ANTH, BIOC, BIOL, BIOS, BNFO, CHEM, CLSE, CMSC, EDUS, EGRB, EPID, FRSC, HGEN, MATH, MEDC, MEDP, MICR, NANO, NEUS, OPER, PATH, PCEU, PHAR, PHIS, PHTX, PSCI, PSYC or STAT		
Directed research		40
LFSC 697	Directed Research in Integrative Life Sciences	
Total Hours		64

- Does not count toward three credit-hour restriction for Preparing Future Faculty courses
- Depending on the student's area of research
- Students are expected to enter the program proficient in statistics at the introductory level, as exemplified by STAT 543 or BIOS 543. Students not at this level, as evidenced by prior course work, will be required to take STAT 543 or BIOS 543 or an equivalent course.
- Based on research interest and approved by research advisory committee
- Only three credits of Preparing Future Faculty (GRAD) courses will be accepted toward the nine credit hours of electives (exclusive of OVRP Responsible Conduct of Research).

Total graduate credit hours required (minimum) 64

Graduate program director

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Program website: lifesciences.vcu.edu/academic-programs/phd-in-integrative-life-sciences (<http://lifesciences.vcu.edu/academic-programs/phd-in-integrative-life-sciences>)