

# CHEMISTRY, DOCTOR OF PHILOSOPHY (PH.D.)

## Program goal

The Department of Chemistry is committed to the dual mission of teaching and research at the bachelor's, master's and doctoral level. In teaching, the purpose is to provide high quality education in chemistry to students in preparation for professional careers at all levels. In research, the goals are to advance the science of chemistry, to keep faculty on the forefront of the field and to maintain an educational program consistent with the latest technology and development of the discipline. Service to the chemical profession is also an important aspect of the department's activities.

## Student learning outcomes

1. Demonstrate expertise (breadth and depth) in chemistry
2. Demonstrate appropriate ability to design and conduct experimental research
3. Demonstrate ability to analyze data critically and to design experiments independently
4. Develop competency in the responsible conduct of research
5. Develop effective oral and written communication skills

## 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 (<http://www.graduate.vcu.edu>) 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 academic regulations section for additional information on academic regulations for graduate students.** (<http://bulletin.vcu.edu/academic-regs>)

## 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 academic regulations section for additional information on degree candidacy requirements.** (<http://bulletin.vcu.edu/academic-regs/grad/candidacy>)

## 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 academic regulations section for additional information on graduation requirements.** (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info>)

## Other information

The Department of Chemistry graduate handbook is available online (<http://chemistry.vcu.edu/graduate-programs/graduate-handbook>).

**Apply online at** [graduate.admissions.vcu.edu](http://graduate.admissions.vcu.edu) (<http://www.graduate.admissions.vcu.edu>).

## Admission requirements

Degree:	Semester(s) of entry:	Deadline dates:	Test requirements:
Ph.D.	Fall	Mar 15	GRE-General
	Spring	Nov 15	

In addition to the general admission requirements of the VCU Graduate School (<http://bulletin.vcu.edu/graduate/study/admission-graduate-study/admission-requirements>), the following requirements represent the minimum acceptable standards for admission:

1. Have a bachelor's degree from an accredited college or university with 30 credit hours in chemistry.
2. Admission on a provisional basis is possible for a student temporarily lacking this expected chemistry background.

## Degree requirements

In addition to general VCU Graduate School graduation requirements (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info>), students are required to complete course work in core and elective courses and to conduct significant research.

1. Credit hour requirements: Students in the Ph.D. in Chemistry program are required to earn a minimum of 60 graduate-level credit hours beyond the baccalaureate. At least one-half of the credit hours presented for graduation must be at the 600 level or higher.
2. Proficiency exams: Students must demonstrate competency in analytical, inorganic, organic and physical chemistry by satisfactory performance on the proficiency exams or with a minimum grade of B in the appropriate course. These examinations are at the level of sound undergraduate courses and are offered preceding the start of the school's fall and spring semesters. These tests are used to

evaluate the student's strengths and weaknesses, and the student's program is planned accordingly.

3. Doctoral candidacy: The student is required to complete written and oral examinations in his/her major field to become a doctoral candidate. The written examinations consist of a series of cumulative exams based on the chemistry literature. The oral examination includes the presentation and defense of the proposed dissertation research.
4. Dissertation: Students must conduct a substantial original investigation under the supervision of their adviser. Students who wish to include a chemical education component in their research will choose two advisers, one in the cognate area, and one in the area of chemical education. All formal requirements for the degree are otherwise the same as for any doctoral student. Students must prepare dissertations reporting the results of the research and analyzing its significance in relation to existing scientific knowledge. An oral defense of the dissertation will be held. Full-time students should complete the degree requirements in four to five years.

## Curriculum requirements

Course	Title	Hours
<b>Required didactic courses</b> <sup>1</sup>		
Select three core courses of the following four areas: analytical, inorganic, organic and physical <sup>2</sup>		9
CHEM 504	Advanced Organic Chemistry I	
CHEM 510	Atomic and Molecular Structure <sup>4</sup>	
or CHEM 511	Chemical Thermodynamics and Kinetics	
CHEM 620	Advanced Inorganic Chemistry I	
CHEM 63x or ENGR 691 (courses in analytical area) <sup>3</sup>		
CHEM 698	Investigations in Current Chemistry Literature (0.5 credit hour) <sup>5</sup>	1
Select eight credit hours of the following recommended electives, in consultation with adviser:		8
BIOC 500-level (except BIOC 505, BIOC 506 and BIOC 507)		
BIOC 530	Biochemistry, Cell and Molecular Biology Module 1: Protein Structure and Function	
BIOC 531	Biochemistry, Cell and Molecular Biology Module 2: Basic Metabolism	
BIOC 532	Biochemistry, Cell and Molecular Biology Module 3: Central Dogma of Molecular Biology	
BIOC 533	Biochemistry, Cell and Molecular Biology Module 4: Lipids/Membranes and Bioenergetics	
BIOC 602	Physical Properties of Macromolecules	
BIOS 543	Graduate Research Methods I	
or STAT 543	Statistical Methods I	
BIOS 544	Graduate Research Methods II	
or STAT 544	Statistical Methods II	
CHEB 601	Chemical Biology I	
CHEB 602	Chemical Biology II	
CHEM 500-level		
CHEM 600-level		
CHEM 610	Applied Quantum Chemistry	
CHEM 611	Molecular Spectroscopy	

CHEM 612	Modern Statistical Mechanics: Fundamentals and Applications	
CHEM 615	Chemical Thermodynamics	
CHEM 616	Chemical Kinetics	
CHEM 620	Advanced Inorganic Chemistry I	
CHEM 621	Advanced Inorganic Chemistry II	
CHEM 630	Electroanalytical Chemistry	
CHEM 631	Separation Science	
CHEM 632	Chemometrics	
CHEM 633	Mass Spectrometry	
CHEM 634	Surface Science	
CHEM 635	Spectrochemical Analysis	
CHEM 691	Topics in Chemistry	
CHEM 698	Investigations in Current Chemistry Literature <sup>5</sup>	
ENGR 591	Special Topics in Engineering	
ENGR 691	Special Topics in Engineering	
MEDC 541	Survey of Molecular Modeling Methods	
MEDC 609	Advanced Organic Synthesis: A Target-oriented Approach	
MEDC 670	Advanced Molecular Modeling Theory and Practice	
NANO 570	Nanoscale Physics	
NANO 571	Nanoscale Chemistry	
NANO 650	Experimental Techniques in Nanoscience I	
NANO 651	Experimental Techniques in Nanoscience II	
NANO 660	Theoretical Studies of Nanostructures	
NANO 661	Computational Nanoscience	
PHYS 550	Techniques in Material Research	
PHYS 573	Analytical Methods in Physics	
PHYS 576	Electromagnetic Theory	
PHYS 580	Quantum Mechanics	
PHYS 591	Topics in Physics	
PHYS 661	Surface and Materials Physics	
PHYS 691	Special Topics	

### Other required courses

CHEM 690	Research Seminar in Chemistry <sup>6</sup>	1-8
CHEM 692	Chemistry Seminar Presentation <sup>6</sup>	2
CHEM 693	Chemistry Perspectives and Ethics <sup>7</sup>	1
CHEM 697	Directed Research <sup>8</sup>	30

1

Students must earn a minimum of 18 credit hours in eight didactic graduate courses, not including credit for CHEM 690, CHEM 692, CHEM 693 or CHEM 697.

2

One of these courses may be waived upon satisfactory proficiency exam scores. The number of required credit hours for the degree does not change.

3

The ENGR 691 topics course must be materials characterization.

4

In some cases, students may be required to enroll in both CHEM 510 and CHEM 511 because of proficiency exam scores.

5

Students are expected to enroll in CHEM 698 (1 credit hour) once during their graduate studies, prior to the semester of their literature seminar presentation (CHEM 692). Note: A maximum of two credit hours of CHEM 698 may be presented toward the didactic course graduation requirements to count as one course.

6

Students are expected to participate in the department's seminar program by enrolling in CHEM 690 or CHEM 692 every spring and fall semester. At least two formal talks are to be presented in the seminar program by enrolling twice in CHEM 692 (one credit hour).

7

Students are expected to enroll in CHEM 693 within the first year of study.

8

Students must enroll in CHEM 697 (one credit hour minimum) every spring and fall semester for a minimum of 30 total credit hours. If the required minimum of 60 credit hours for the degree is not fulfilled after completion of all other course requirements, then additional credit hours of CHEM 697 may satisfy remaining credit hours for the degree.

**The minimum total of graduate credit hours required for this degree is 60.**

**Graduate program director**

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**Program website:** [chemistry.vcu.edu](http://chemistry.vcu.edu) (<http://chemistry.vcu.edu>)