Introduction

What is chemistry? At its essence chemistry is the study of matter. Chemistry tries to understand what that matter can do, what is its composition and what are the underlying principles that govern the behavior of that matter. Chemistry is often considered the central science because matter is so fundamental to all science.

Traditionally, chemistry has been organized into the areas of inorganic chemistry, organic chemistry, biochemistry, analytical chemistry and physical chemistry. These fields all touch upon other disciplines such as physics, biology, medicine, geosciences and engineering. Much of the current research in chemistry is done at the interface between chemistry and these fields. The chemistry faculty at Vanderbilt is actively involved with this interdisciplinary research and hold appointments in the Institute for Chemical Biology, the Vanderbilt Institute for Biomedical Research and Education, and the Vanderbilt Institute for Nanoscience and Engineering. A list of the chemistry department faculty, their research interests and the interdisciplinary institutes can be found on the chemistry department's home page.

The Chemistry Major

In addition to preparing you to for a career in the field of chemistry, the chemistry major develops rigorous thinking and analytical skills making it a highly marketable degree. In addition to working in areas of chemistry, chemistry majors often end up in such diverse areas as medicine, engineering, pharmacology, law, forensics, environmental policy, etc.

Requirements for chemistry major: There is one basic set of requirements for chemistry majors at Vanderbilt. These requirements meet the American Chemical Society (ACS) criteria for the certified ACS chemistry major. This major requires that all chemistry majors take foundational courses in inorganic, physical, organic, biochemistry and analytical. In addition to those foundational courses students take at least 3 more in-depth courses. The chemistry department has outlined some options for structuring the chemistry major based on a student's career goals and interests. Further assistance on course selection can be obtained from your chemistry major advisor.

Concentration in chemistry

Required Course(s)		Hours towards major
Chem 1601,1602 & 1601L,1602L or AP credit	(general chemistry & lab)	0
Chem 2221,2222 (or 2211,2212) & 2211L,2222L	(organic chemistry & lab)	8
Chem 2100, 2100L	(analytical chemistry & lab)	4
Chem 3300 or 3310	(physical chemistry)	3
Chem 3315	(physical chemistry lab)	1
BSCI 2520	(biochemistry)	3
Chem 3010	(inorganic chemistry)	3
*Two "in-depth chemistry" courses		6
Chem 4965, 4966	(advanced integrated labs)	6
Minimum Hours for Chemistry Major		34

* In-depth chemistry courses include all 2000-level chemistry courses not explicitly required, except for Chem 3600 and 3980, 4980, 4999. Other in-depth chemistry courses are Chemical and Biomolecular Engineering 3200 and 3250, and Earth and Environmental Sciences 4600, and any 5000-level chemistry lecture courses. (Qualified seniors interested in 5000-level courses must obtain approval from the course instructor, their advisor, and the Director of Graduate Studies in Chemistry. Further details are found in the Academic Policies for the College of Arts and Sciences.) A maximum of 3 credit hours of chemistry research (3860) may be counted as in-depth chemistry course hours.

In addition to the courses listed above, the following courses are also required for the major: Physics 1501,1502 or 1601,1602 and their corresponding labs, and one year of calculus (math 1300,1301). Additional math courses such as Math 2300 and 2820 are highly recommended for the chemistry major.

Options for the chemistry major

In-depth chemistry courses can be chosen so as to define a focus area within chemistry. Students should consult with their major advisor about focus area options, or to formulate an individualized focus area option. All of the options for concentration in chemistry meet the guidelines approved by the American Chemical Society for the chemistry major. Recommendations of "in-depth" courses for the specialized major options are provided below. Independent research is encouraged as an elective for all options of the chemistry major. Up to 3 credit hours of Chem 3860 (undergraduate research) may be counted towards the in-depth chemistry electives.

Chemical Sciences Focus:

All majors who are thinking of pursuing a career in chemistry – either in industry or academia –should consider this option. This option provides a solid, broad foundation of chemistry on which to build. Given the interdisciplinary nature of modern chemistry, having this broad background allows for the greatest flexibility in future career pathways and provides an excellent preparation for graduate programs in chemistry.

Suggested in-depth chemistry electives: 3120, 3300 or 3310, 3860
Additional recommended courses: Chem 3600, Math: statistics, differential equations, linear algebra

Chemical Biology Focus:

Using chemical tools and concepts to investigate biological systems is fundamental to chemical biology. The journal *Nature Chemical Biology* defines chemical biology as "the use of chemistry to advance a molecular understanding of biology and the harnessing of biology to advance chemistry." Biological chemistry builds upon the disciplines of medicinal chemistry, biochemistry, pharmacology, genetics, bioorganic and organic chemistry.

Suggested in-depth chemistry electives: 3020, 3710, 4720, 5420, 3860
Additional recommended courses: BSCI: 2210/2210L (genetics), 2201 (cell biology)

Environmental Chemistry Focus:

Environmental chemistry investigates the chemical phenomena that occur in nature. Environmental chemistry is multidisciplinary in nature spanning atmospheric, aquatic, and soil chemistry with a reliance on analytical chemistry for methods of analysis. Therefore, the environmental chemistry option builds upon a strong background in analytical chemistry. Fundamental issues such as ground water pollution, wastewater treatment, ozone depletion, greenhouse gas emissions require an understanding of environmental chemistry.

Suggested in-depth chemistry electives: 3120, 3300 or 3310, EES 4600 (geochemistry)
Additional recommended courses: ENVE 4600 (environmental chemistry), EES 1080 (earth and atmoshphere), 1030,1030L (Oceanography)

Materials Science Focus:

Materials chemistry is concerned with designing and synthesizing new materials with specific useful properties and determining the relationships between the desired physical properties and the composition and structure of these new materials. Materials chemistry encompasses all size regimes from bulk materials to nanoscale materials. Synthetic chemistry is utilized to create these devices or building blocks. Analytical techniques such as scanning tunneling electron microscopy or atomic force microscopy are used to probe the composition and architecture of the structures. Synthetic chemistry (inorganic and organic), physical chemistry and analytical chemistry are all important components of this field.

Suggested in-depth chemistry electives: 3120, 3300 or 3310, 3630, 2610, 5610, 5620
Additional recommended courses: MSE 1500, 2500 (materials science I & II)

Honors in Chemistry (available for all focus options)

Students with a 3.4 or greater GPA in chemistry and an 3.3 overall GPA at the start of their junior year wishing to do honors will register for the honors research courses (Chem 3980, 4980, 4999 – each is 2 credit hours) beginning spring semester junior year. The advanced integrated lab requirements would be waived in lieu of the Chem 4965 and Chem 4966 registrations. Honors candidates will be expected to take the Graduate Record Examination in Chemistry during the fall semester of their senior year or take the chemistry assessment exam spring semester of their senior year. The student must present a thesis on the research done under 3980-4980-4999 and pass an oral examination on it. Students are expected to maintain the GPA of at least 3.4 in chemistry while honors candidates. Additional information may be found in the chapter on Special Programs in the College.

Licensure for Teaching

Candidates for teacher licensure in chemistry at the secondary level should refer to the chapter on Licensure for Teaching in the Peabody College section of course catalog. One of the advanced lab courses will be considered fulfilled by completing the Peabody student teaching requirements.

Choosing a chemistry major advisor

Any chemistry faculty member can be your major advisor. Just ask. By signing your declaration of major form that faculty member will become your major advisor. Make sure one copy of the major declaration form is left the chemistry department office. The other copy of the major declaration form will go to your college registrar's office. If you have no preference for a faculty advisor (or if your preferred choice cannot take more advisees), see the Director of Undergraduate Studies in Chemistry to get set up with an advisor. While you will need to visit your major advisor at least once a semester discuss registration for the upcoming semester, it is a good idea to visit more often. Your advisor can be a source of advice on a range of topics and issues.

Courses for 1st and 2nd year students

During the first two years students will take courses that provide the foundation for in-depth courses. If you are planning a chemistry major and wish to graduate in 4 years then it is important to start your chemistry courses in your first year. Most students will start their chemistry career in General Chemistry and lab, Chem 1601, 1602 / 1601L, 1602L. Students with chemistry AP scores of 5 are strongly encouraged to use their AP credit for Chem 1601, 1602 / 1601L, 1602L and start chemistry courses in Chem 2211, 2212 / 2221L, 2222L (advanced placement organic chemistry and lab). It is often useful to take analytical chemistry, 210/212a, during these first two years schedule permitting. Students should be taking calculus, preferably the Math 1300/1301 sequence with the goal of completing Math 2300 by the end of 2nd year. Physics 1601, 1602 / 1601L, 1602L is also recommended during the first two years (PHYS 1501,1502 / 1501L, 1502L is also acceptable). Additionally, AXLE requirements will need to be started. A couple of sample course schedules are show below.

Starting in General Chemistry (1601)

	Year 1		Year 2	
Fall	**Chem 1601/1601L**	4	**Chem 2221/2221L**	4
	Math 1300	4	Math 2300	3
	Engl 1xxxW	3	Langauge 110x	3
	*BSCI 1510/1510L	4	*Physics 1601/1601L	4
	Visions	*0*	Elective (or AXLE)	3
			***(Chem 2100/2100L)*	
	Semester Hours	15		17
Spring	**Chem 1602/1602L**	4	**Chem 2222/2222L**	4
	Math 1301	4	Elective (or AXLE)	3
	*BSCI 1511/1511L	4	AXLE	3
	Visions	*0*	*Physics 1602/1602L	4
	Fresh Seminar	*3*		
	Semester Hours	15		14

Starting in Organic Chemistry (2211)

	Year 1		Year 2	
Fall	**Chem 2211/2221L**	4	****Chem 2100/2100L**	4
	Math 1300	4	Math 2300	3
	Engl 1xxxW	3	Langauge 110x	3
	*BSCI 1510/1510L	4	*Physics 1601/1601L	4
	Visions	*0*		
	Semester Hours	15		14
Spring	**Chem 2212/2222L**	4	AXLE	3
	Math 1301	4	*Physics 1602/1602L	3
	*BSCI 1511/1511L	4	Elective	4
	Visions	*0*	Elective (or AXLE)	3
	Fresh Seminar	*3*		3
	Semester Hours	15		13

* BSCI and PHYS courses can be moved back a year if desired. Depending on your area of interest, you may not need BSCI 1511/1511L. **Analytical chemistry can be taken fall of sophomore or junior year, which ever fits best

Courses for 3rd and 4th year students

Of the foundation courses in chemistry, physical chemistry, 3300 and 3310, and physical chemistry lab, 3315 are usually taken 3rd year. Inorganic chemistry (3010) is often taken 4th year. Biochemistry, BSCI 2520, can be taken any time after organic chemistry. BSCI 1510 is recommended as a preparation for BSCI 2520. Additionally, BSCI 2520 is a prerequisite for Chem 4720, Chemical Principles for Drug Design and Development. Students should start planning which in-depth courses they will pursue by the end of sophomore year. Students considering an Honors project should contact the Dir. of Undergraduate Studies in the fall of the 3rd year. During the 4th year students will take the capstone lab courses in both the fall and spring semesters, with the exception of Honors majors. Students pursuing a licensure for teaching through Peabody will only be required to take one capstone lab during 4th year.

An example of a possible schedule is shown below:

	Year 3		Year 4	
Fall	**Chem In-depth or Chem 3300**	3	**Chem 3010**	3
	Elective (or AXLE)	3	**Chem 4865**	3
	BSCI 2520	3	Elective (or AXLE)	3
	Elective (or AXLE)	3	Elective	3
	***Chem 2100/2100L**	4	**Chem In-Depth**	3
		16		15
Spring	**Chem In-Depth or Chem 3310**	3		3
	Elective (or AXLE)	3	**Chem 4866**	3
	Elective	3	**Chem In-Depth**	3
	Elective	3	Elective (or AXLE)	3
	Chem 3315	1	Elective	3
	Chem In-depth	3		
		16		14

* If the analytical chemistry was not taken previously.

Undergraduate research

Undergraduate research is an excellent way to experience modern, current chemistry by working in one of the research labs under the supervision of a faculty member. You will put your coursework into practice as well as learn many advanced chemistry topics. There are two options for research: 1) you can get credit for chemistry research by registering for Chem 3860 (regular research) or Chem 3980/4980/4999 (honors research) or 2) you can be paid to do research (this is most common during the summer).

To find out about the types of research in the chemistry department, visit the chemistry department home page and view the list of faculty and their research projects. Contact those faculty members whose research interests match your interests to see if there are any available undergraduate research positions.

Do not wait until the semester has started to arrange a research position! Research space is often limited, so contact faculty in advance of the start of a semester to find out about openings. You will need to be officially registered for research by the end of the change period. In order to register for undergraduate research you must find a faculty research mentor with an appointment in the chemistry department. Research with faculty members in departments other than chemistry (like the VU medical center) will generally not qualify for Chem 3980 or honors research credit. Once you have found a research mentor obtain a “research contract” form from the research course instructor to be filled out by you and your research supervisor. Once the research course instructor has approved the research contract you should contact the Dir. of Undergraduate Studies (Dr. Adam List) so that you can be officially registered for undergraduate research.

Summer research

Summer research opportunities, while generally not receiving course credit, can be very valuable to your development as a chemist. The summer allows for a much greater time commitment on the part of students, providing a more substantial and deeper exposure to chemistry research. There exist several fellowship opportunities on campus for chemistry majors. The Stephen Harris Cook Memorial Fellowship is open to juniors involved in undergraduate research who plan to continue the research in the fall semester of their senior year. The Fellowship provides a stipend for 10 weeks of research during the summer. The Vanderbilt Undergraduate Summer Research Program also provides a stipend for 10 weeks of summer research and is

open to students across campus who are doing research with faculty in A&S, Blair, Peabody, Engineering and VUIIS (Vanderbilt Univ. Institute of Imaging Science). Additionally, many universities around the country have summer research opportunities available. The NSF has a program, research experience for undergraduates, REU, that provides funds for universities to bring undergraduates on campus for summer research. Contact your advisor or Adam List for information (many informational flyers for summer research programs are posted outside SC 5501).

Chemistry Majors Group - Student Members of the American Chemical Society

The chemistry majors get together to participate in a variety of activities, such as "Mole Day" celebrations, traveling to ACS meetings, doing science demonstrations at the Nashville Adventure Science Center, doing classroom demonstrations in conjunction with Vanderbilt Students Volunteering for Science (VSVS), tutoring, and picnics. Membership in the American Chemical Society is optional but recommended. The ACS offers an affordable membership for students, with access to the ACS membership benefits. Information for the ACS can be found at www.acs.org and information specifically for undergraduates can be found at http://undergrad.acs.org. Dr. Hare (alissa.a.hare@vanderbilt.edu) is the faculty advisor for the Student Members of the American Chemical Society.

Heath Professions Advising

Students interested using the chemistry major as preparation for careers in the health professions are strongly encouraged to visit the Health Professions Advising Office (HPAO). The HPAO has a wealth of information about the health professions as well as providing assistance with medical school applications. (http://www.vanderbilt.edu/hpao/)

Graduate School in Chemistry

If you are interested in career in chemistry you may want to consider graduate school. In most cases, having a graduate degree will provide a higher pay than not having a graduate degree. There is usually a wider range of career options available if you have an advanced degree. For instance, colleges require a Masters or a Ph.D. in order to teach courses in chemistry, with preference for a Ph.D. Many industrial research positions are only open to employees with advanced degrees. Chemistry research experience is often essential for admission to the top-level Ph.D. graduate programs.

Most terminal Master's degree programs require you to pay for the degree. However, most Ph.D. programs provide stipends for teaching or research assistantships and tuition reimbursement while you are a Ph.D. candidate. In most cases you do not need to obtain a Master's degree on the way to a Ph.D. Contact your advisor if you are interested in graduate school. The admissions process for graduate schools begins in the fall of your senior year. You will want to take the general GRE exam and may need to take the chemistry subject GRE as well (not all grad schools in chemistry require this). You will want to line up at least three faculty members to write letters of recommendation for you. While most applications for grad school do not close until March, strong candidates who apply early will often be offered topping up awards, additional money each year on top the basic graduate student stipend.