

UNDERGRADUATE CHEMISTRY HANDBOOK

Fall 2008



Student Name _____

Freshman Advisors

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Introduction

Chemistry is central to the sciences, the understanding of the physical world, and the study of biological systems. Chemistry is the science of transformations and energetics of materials at the molecular level. Chemistry has applications from the nanoscale to the macroscopic. Chemists use their training and creativity to improve the quality of life by creating new drugs, inventing new materials, improving the efficiency of processes, developing new energy systems, and providing critical data for policy decisions. A chemistry degree provides a solid foundation to pursue a range of career directions spanning fundamental research, applied research tied closely to engineering or health professions, chemical education, and technical areas in business and law. Virginia Tech offers two course curricula leading to undergraduate degrees in Chemistry, the Bachelor's of Science (B.S.) and the Bachelor's of Arts (B.A.):

THE B.S. CURRICULUM

The curriculum leading to the B.S. degree in chemistry prepares students for careers as professional chemists in industry or government or to continue their academic training in graduate study in chemistry or related fields. It is also suitable to prepare for pre-professional school or high school teaching. The B.S. degree meets the guidelines of the American Chemical Society (ACS) for an ACS-certified degree in chemistry.

THE B.A. CURRICULUM

The B.A. curriculum allows greater flexibility to include more elective courses for students who wish to tailor a program to their individual goals, including pursuing a double major. It is also suitable for students interested in pursuing graduate study in an area related to chemistry, professional school, high school teaching with multiple endorsements, or business. In deciding to start either the B.A. or the B.S. degree, one major difference for freshman year is the different math courses in the two curricula. Due to the greater math requirements of the B.S., it is easier to start on the B.S. and switch to the B.A. rather than vice versa.

This handbook outlines the requirements to complete the Chemistry B.S. and B.A. degrees and provides answers to common questions that students have about choosing and completing a degree at Virginia Tech. There are two important notes to the information presented here: (1) the Virginia Tech Undergraduate Catalog is the official reference source on academic policies, and (2) this handbook includes the most current checksheets, however degree requirements can change and you should obtain the appropriate checksheet from the Chemistry Department website for your graduation term.

Thank you for choosing chemistry! For more information contact

Prof. Brian Hanson
Director of Undergraduate Programs
& Associate Chair
103 Davidson Hall
Email: hanson@vt.edu

Anna Hawthorne
Undergraduate Program Coordinator
301A Davidson Hall
540-231-4239
Email: chemadv@vt.edu

or visit the Chemistry Department's Undergraduate Programs website:

<http://www.chem.vt.edu/undergrad>

**College of Science
Department of Chemistry
Bachelor of Science Checksheet
(for students graduating in Calendar Year 2010)**

PART 1: CURRICULUM FOR LIBERAL EDUCATION (CLE) REQUIREMENTS

(CLE requirements and approved courses are available online:

<http://www.cle.prov.vt.edu/guides/index.html>)

(credit hours in parentheses)

- I. Writing and Discourse** (Area 1: 6 credits + ViEWS)
ENGL 1105-1106¹ Freshman English (3) _____, (3) _____
& ViEWS requirement (*Fulfilled by courses required for degree.*)²
- II. Ideas, Cultural Traditions, and Values** (Area 2: 6 credits required) (3) _____
(Select from approved CLE courses) (3) _____
- III. Society and Human Behavior** (Area 3: 6 credits required) (3) _____
(Select from approved CLE courses) (3) _____
- IV. Scientific Reasoning and Discovery** (Area 4)³
Fulfilled by courses required for degree.
- V. Quantitative and Symbolic Reasoning** (Area 5)⁴
Fulfilled by courses required for degree.
- VI. Creativity and Aesthetic Experience** (Area 6: 3 credits required) (3) _____
(Select from approved CLE courses; must be a three-credit course.)
- VII. Critical Issues in a Global Context** (Area 7: 3 credits required) (3) _____
(Select from approved CLE courses)

PART 1: (CLE) credit hour requirement:

24 credits

PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS

- I. Chemistry Courses** (46 credits)
 - CHEM 1055-1056¹ General Chemistry for Majors (4) _____, (4) _____
 - CHEM 1065-1066¹ General Chemistry for Majors lab (1) _____, (1) _____
 - CHEM 2154¹ Analytical Chemistry for Majors (4) _____
 - CHEM 2164¹ Analytical Chemistry for Majors lab (1) _____
 - CHEM 2424 Descriptive Inorganic Chemistry (3) _____
 - CHEM 2565-2566¹ Principles of Organic Chemistry (3) _____, (3) _____
 - CHEM 2555¹-2556 Organic Syn-Tech lab (2) _____, (2) _____
 - CHEM 3615-3616 Physical Chemistry (3) _____, (3) _____
 - CHEM 3625-3626² Physical Chemistry lab (1) _____, (1) _____
 - CHEM 4014² Survey of Chemical Literature (1) _____
 - CHEM 4114 Instrumental Analysis (3) _____
 - CHEM 4124 Instrumental Analysis Lab (1) _____
 - CHEM 4404 Physical Inorganic Chemistry (3) _____
 - CHEM 4414 Inorganic Synthesis & Techniques lab (2) _____
- II. Mathematics Courses** (16 credits)
 - MATH 1114¹ Elementary Linear Algebra (2) _____
 - MATH 1224¹ Vector Geometry (2) _____
 - MATH 1205-1206¹ Calculus (3) _____, (3) _____

MATH 2214 Introduction to Differential Equations (3) _____
 MATH 2224¹ Multivariable Calculus (3) _____

III. Physics Courses (8 credits)

PHYS 2305¹-2306 Foundations of Physics I & II (incl. lab) (4) _____, (4) _____

IV. Restricted Electives (9 credits)

BCHM 3114 or 4115 Biochemistry elective (3) _____
 STAT or CS course Statistics or Computer Science elective (3) _____
NOT CS 1004
 CHEM 4xxx CHEM/BCHM/BIOC/CHE elective (3) _____
4000-level or higher

V. FREE ELECTIVES (sufficient to achieve 120 credit graduation requirement or more)

() _____ () _____ () _____ () _____
 () _____ () _____ () _____ () _____
 () _____ () _____ () _____ () _____

PART 2: College and department credit hour requirement: 96 credits

NOTES:

- ¹ For “satisfactory progress towards degree,” these courses and their prerequisites must be completed by the time the student has attempted 72 hours.
- ² CHEM 3626 and CHEM 4014 satisfy the department’s ViEWS (Visual Expression, Written and Spoken) communication requirement.
- ³ PHYS 2305 and PHYS 2306 satisfy CLE Area 4.
- ⁴ MATH 1205 and MATH 1206 satisfy CLE Area 5.

Credit hours and GPA requirements: Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater. The in-major GPA is calculated from all chemistry courses except that not more than 6 hours of CHEM 2974, 4974, and 4994 will be included.

Prerequisites: This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Language study requirement: The College of Science language requirement may be met by (1) completing 3 units of a single foreign or classical language in high school; (2) earning 6 semester hours of college-level foreign or classical language credit or American Sign Language; or (3) receiving credit-by-examination for a foreign or classical language or American Sign Language. (See the Undergraduate Catalog for more information.) Credits to satisfy the Language Study Requirement are in addition to the 120-credit graduation requirement for the Chemistry degree.

Substitutions: Students with chemistry credits due to transferring into the major, taking summer classes, or transferring credits from elsewhere may substitute the non-majors chemistry courses for the majors chemistry courses. Course substitutions must be approved by the Chemistry Department’s Director of Undergraduate Programs. Since CHEM 2545,2546 does not satisfy the prerequisite for CHEM 2556 (due to training on specific instrumentation), two or more credits of CHEM 4994 may substitute for CHEM 2556 to meet the requirement of 400 lab hours beyond general chemistry for an ACS-approved degree.

Required Courses	Equivalent Substitution
MATH 1205	MATH 1016
MATH 1206	MATH 2015

**College of Science
Department of Chemistry
Bachelor of Arts Checksheet
(for students graduating in Calendar Year 2010)**

PART 1: CURRICULUM FOR LIBERAL EDUCATION (CLE) REQUIREMENTS

(CLE requirements and approved courses are available online:

<http://www.cle.prov.vt.edu/guides/index.html>)

(credit hours in parentheses)

- | | |
|---|------------------------|
| I. Writing and Discourse (Area 1: 6 credits + ViEWS)
ENGL 1105-1106 ¹ Freshman English
& ViEWS requirement (<i>Fulfilled with
CHEM 4014 and one of the following: CHEM 3626 or 4994</i>) ² | (3) _____, (3) _____ |
| II. Ideas, Cultural Traditions, and Values (Area 2: 6 credits required)
(Select from approved CLE courses) | (3) _____
(3) _____ |
| III. Society and Human Behavior (Area 3: 6 credits required)
(Select from approved CLE courses) | (3) _____
(3) _____ |
| IV. Scientific Reasoning and Discovery (Area 4) ³
<i>Fulfilled by courses required for degree.</i> | |
| V. Quantitative and Symbolic Reasoning (Area 5) ⁴
<i>Fulfilled by courses required for degree.</i> | |
| VI. Creativity and Aesthetic Experience (Area 6: 3 credits required)
(Select from approved CLE courses; must be a three-credit course.) | (3) _____ |
| VII. Critical Issues in a Global Context (Area 7: 3 credits required)
(Select from approved CLE courses) | (3) _____ |

PART 1: (CLE) credit hour requirement:

24 credits

PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS

- | | |
|--|----------------------|
| I. Chemistry Courses (34 credits) | |
| CHEM 1055-1056 ¹ General Chemistry for Majors | (4) _____, (4) _____ |
| CHEM 1065-1066 ¹ General Chemistry for Majors lab | (1) _____, (1) _____ |
| CHEM 2154 ¹ Analytical Chemistry for Majors | (4) _____ |
| CHEM 2164 ¹ Analytical Chemistry for Majors lab | (1) _____ |
| CHEM 2424 Descriptive Inorganic Chemistry | (3) _____ |
| CHEM 2565-2566 ¹ Principles of Organic Chemistry | (3) _____, (3) _____ |
| CHEM 2545 -2546 ¹ Organic Chemistry lab | (1) _____, (1) _____ |
| CHEM 4615-4616 Physical Chemistry for Life Sciences | (3) _____, (3) _____ |
| CHEM 3625 Physical Chemistry lab | (1) _____ |
| CHEM 4014 ² Survey of Chemical Literature | (1) _____ |
| II. Mathematics Courses (12 credits) | |
| MATH 1015-1016 ¹ Elementary Calculus I | (3) _____, (3) _____ |
| MATH 2015-2016 ¹ Elementary Calculus II | (3) _____, (3) _____ |
| III. Physics Courses (8 credits) | |
| PHYS 2205 ¹ - 2206 General Physics | (3) _____, (3) _____ |
| PHYS 2215 ¹ - 2216 General Physics Lab | (1) _____, (1) _____ |

IV. Restricted Electives (11 credits)

STAT or CS course	Statistics or Computer Science elective <i>NOT CS 1004</i>	(3) _____
CHEM 3xxx-4xxx	CHEM/BCHM/BIOC/CHE electives <i>3000-level or higher</i>	(3) _____, (3) _____
CHEM ViEWS ²	Additional ViEWS requirement <i>Select from CHEM 3626, CHEM 4994, or department-approved alternative.</i>	(2) _____

V. FREE ELECTIVES (sufficient to achieve 120 credit graduation requirement or more)

() _____	() _____	() _____	() _____
() _____	() _____	() _____	() _____
() _____	() _____	() _____	() _____
() _____	() _____	() _____	() _____

PART 2: College and department credit hour requirement:**96 credits****NOTES:**

- ¹ For “satisfactory progress towards degree,” these courses and their prerequisites must be completed by the time the student has attempted 72 hours.
- ² CHEM 4014 satisfies part of the University Writing-Intensive and ViEWS (Visual Expression, Written and Spoken) communication requirement. **Note that one additional Writing-Intensive or ViEWS course is required.** B.A. majors who wish to complete their ViEWS requirements in Chemistry may enroll in the second semester of Physical Chemistry lab (CHEM 3626) or take three credits of Undergraduate Research with an oral presentation at the Chemistry Undergraduate Symposium.
- ³ PHYS 2206 and PHYS 2216 satisfy CLE Area 4.
- ⁴ MATH 2015 and MATH 2016 satisfy CLE Area 5.

Credit hours and GPA requirements: Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater. The in-major GPA is calculated from all chemistry courses except that not more than 6 hours of CHEM 2974, 4974, and 4994 will be included.

Prerequisites: This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Language study requirement: The College of Science language requirement may be met by (1) completing 3 units of a single foreign or classical language in high school; (2) earning 6 semester hours of college-level foreign or classical language credit or American Sign Language; or (3) receiving credit-by-examination for a foreign or classical language or American Sign Language. (See the Undergraduate Catalog for more information.) Credits to satisfy the Language Study Requirement are in addition to the 120-credit graduation requirement for the Chemistry degree.

Substitutions: Students with chemistry credits due to transferring into the major, taking summer classes, or transferring credits from elsewhere may substitute the non-majors chemistry courses for the majors chemistry courses. Course substitutions must be approved by the Chemistry Department’s Director of Undergraduate Programs.

Required Courses	Equivalent Substitution
MATH 1015, 1016	MATH 1205
MATH 2015	MATH 1206
MATH 2016	MATH 2214, 2224, or 2514
PHYS 2205, 2215	PHYS 2305
PHYS 2206, 2216	PHYS 2306

College of Science
Minor in Chemistry
 For students graduating in calendar year 2010

Chemistry Minor	credits
1000-level CHEM 1035 General Chemistry CHEM 1036 General Chemistry CHEM 1045 General Chemistry Lab CHEM 1046 General Chemistry Lab	(3) ____ (3) ____ (1) ____ (1) ____
2000-level CHEM 2535 Organic Chemistry CHEM 2536 Organic Chemistry CHEM 2545 Organic Chemistry Lab CHEM 2546 Organic Chemistry Lab	(3) ____ (3) ____ (1) ____ (1) ____
3000-level or higher Two additional 3-credit CHEM courses at the 3000-level or higher	(3) ____ (3) ____
Minimum total chemistry credits	(22) ____

Notes:

1. The minimum in-minor GPA to earn the Minor in Chemistry is 2.0.
2. Students are responsible to see that they meet all prerequisites for required courses.
3. Acceptable substitutions for required courses are as follows:

CHEM 1035	CHEM 1055 (General Chemistry for Chemistry Majors) or CHEM 1074 (General Chemistry for Engineers)
CHEM 1036	CHEM 1056 (General Chemistry for Chemistry Majors)
CHEM 1045	CHEM 1065 (General Chemistry for Chemistry Majors Lab) or CHEM 1084 (General Chemistry for Engineers Lab)
CHEM 1046	CHEM 1066 (General Chemistry for Chemistry Majors Lab)
CHEM 2536 and CHEM 2546	CHEM 2114 (Analytical Chemistry)* and CHEM 2124 (Analytical Chemistry Lab)* * This substitution limits a student's upper-level electives to CHEM 4615-4616, which has a physics prerequisite

IMPORTANT WAYPOINTS TO GRADUATION

Freshman year

- attend Orientation, choose math sequence
- attend advising sessions (Fall, Spring) and meet your academic advisor (Spring)

Sophomore year

- choose B.A. or B.S. and organic lab sequence (also try to survive - crunch year for chemists!)

Beginning of Junior Year

- Download degree checksheet for your graduation year
- Apply for Degree on Hokie SPA
- Request DARS Report on Hokie SPA and review with your advisor

End of Junior Year

- add any minors or second majors before being within 30 credits of graduation
- Begin making hotel arrangements for out-of-town guests to attend graduation
- honk if you pass p-chem ☺

Beginning of Senior Year

- Request a new DARS Report on Hokie SPA and review with your advisor

Senior Year (graduation semester)

- Request a new DARS Report on Hokie SPA and review with your advisor

Senior Year (2 months before Graduation)

- Review <http://www.vt.edu/academics/graduationinfo.html> for commencement dates, times and locations
- Visit Bookstore to purchase cap and gown, announcements, etc.

IMPORTANT EVENTS EACH SEMESTER

End of week 1	last day to add classes
End of week 6	last day to drop classes
Tuesday of week 9	course request opens for the next semester
Tuesday of week 10	course request closes for the next semester
Monday of week 14	Drop/Add opens for the next semester
End of week 14	last day to apply late withdrawal policy
Wednesday of week 15	end of classes
Thursday of week 15	reading day
Friday of week 15	final exams begin

!!! Check the calendar on the Registrar's website (<http://www.registrar.vt.edu>) for exact dates each semester.

Advising

ADVISORS

As future colleagues, the Chemistry Faculty wants and expects to know every chemistry major personally. You should, as you move through the program, make an effort to meet and know your professors; they are always available for help and guidance. A complete and current faculty listing is found on the department website. In addition, in their second semester at Virginia Tech, all undergraduate chemistry majors are assigned to a faculty member who serves as their academic advisor. Students may schedule appointments directly with their advisors whenever questions or issues arise. Additionally, it is the students' responsibility to contact their advisor during course request for each upcoming semester. For "emergency" advice when the advisor cannot be located, students should feel free to contact any other advisor from the list below:

Dr. Patricia Amateis	007 Davidson	231-6629	pamateis@vt.edu
Dr. Michael Berg	221 Davidson	231-6837	bergm@vt.edu
Dr. Karen Brewer	1105 Hahn	231-6579	brewer@vt.edu
Dr. Daniel Crawford	1110 Hahn	231-7760	crawdad@vt.edu
Ms. Jeannine Eddleton	009 Davidson	231-8228	jeddleto@vt.edu
Dr. Alan Esker	1107 Hahn	231-4601	aesker@vt.edu
Dr. Felicia Etzkorn	3105 Hahn	231-2235	fetzorn@vt.edu
Dr. Brian Hanson	105 Davidson	231-7206	hanson@vt.edu
Dr. Gary Long	230 Davidson	231-7575	glong@vt.edu
Dr. John Morris	1101 Hahn Hall	231-2472	jrmorris@vt.edu
Dr. Carla Slebodnick	011 Davidson	231-1848	slebod@vt.edu
Dr. James Tanko	3109 Hahn	231-6687	jtanko@vt.edu
Dr. Brian Tissue	406 Davidson	231-3786	tissue@vt.edu
Dr. Gordon Yee	2103 Hahn	231-3090	gyee@vt.edu

In addition to your assigned academic advisor, the Department provides advisors for special programs:

Freshman Advising	Dr. Patricia Amateis and Dr. Brian Hanson
Transfer Student Advising	Dr. Patricia Amateis
Career Advisor*	Dr. Brian Hanson
Honors Advisor	Dr. Brian Hanson
Pre-Med, Dental, and Veterinary	Dr. Michael Berg
Pre-Pharmacy Programs	Dr. Gary Long and Dr. Carla Slebodnick
Teacher Certification	Ms. Jeannine Eddleton

*All chemistry majors should interact at least once a year with Dr. Hanson. However, it is especially critical that rising juniors and seniors discuss their goals and aspirations early in the Fall Semester. Successfully finding the right position after graduation requires proper planning and a coordinated campaign. Dr. Hanson can be reached at 231-7206.

A final note on advising: Advice is just that - advice to you to help you make decisions. Your advisor will provide advice on what he or she thinks will serve you best. Our advisors have been through what you are going through so listen to them and then make decisions that are best for you. You will find that life is a journey full of expected and unexpected curves with many different paths - all different and none of them right or wrong.

PROGRAM OPTIONS FOR CHEMISTRY MAJORS

CO-OP PROGRAM

The Chemistry Department participates in the University Cooperative Education Program. This is a five-year program in which the student alternates a term of study with a term of professional work for a maximum of five work terms prior to the senior year. Students must maintain a 2.0 GPA, complete all scheduled work terms (a minimum of three, one of which must be a fall or spring semester) and satisfactorily complete all reporting requirements in order to graduate as a Co-Op student. Chemistry majors are allowed to enter the program only after freshman year. Co-Op Schedules A or B are listed below to minimize disruption in class scheduling. B.S. majors following Schedule A will need to make the organic lab substitution described at the bottom of the B.S. checksheet, and take Survey of Chemical Literature and Descriptive Inorganic Chemistry during Year 4.

SUGGESTED CO-OP SCHEDULE A

	Fall	Spring	Summer
Year 1	Freshman I	Freshman II	On Own
Year 2	Sophomore I	Work	Sophomore II
Year 3	Work	Work	Junior I
Year 4	Work	Junior II	Work
Year 5	Senior I	Senior II	

SUGGESTED CO-OP SCHEDULE B

	Fall	Spring	Summer
Year 1	Freshman I	Freshman II	Sophomore I
Year 2	Work	Sophomore II	Work
Year 3	Junior I	Work	School
Year 4	Work	Junior II	Work
Year 5	Senior I	Senior II	

For more information, contact the Co-Op Office in Career services (<http://www.career.vt.edu/COOP/COOP1.html>) or Dr. Brian Hanson, Chemistry Co-Op Advisor.

CAREERS IN BUSINESS

Some chemistry students may wish to prepare for managerial, sales, and marketing jobs in the chemical industry. The following courses are recommended: ECON 2005-2006; ACIS 2115-2116; BIT 2405-2406, 3414; MGT 3304, 4394; MKTG 3104; FIN 3055, 3104. Also recommended is COMM 2004.

CHEMISTRY TEACHER CERTIFICATION

Students wishing to become high school chemistry teachers should major in chemistry (either the B.S. or the B.A. program depending on math and other interests) and then enter the fifth-year secondary science teacher licensure program offered by the School of Education:

<http://www.tandl.vt.edu/scied/program.htm>

Students who complete this program will receive the aforementioned chemistry baccalaureate degree, the Master of Arts in Education (MAED), and also be certified to teach chemistry in the Commonwealth of Virginia. Prior to entering the fifth year of this program, students should strive to complete the chemistry degree requirements, including 3 credits of CHEM 4994 Undergraduate Research, and 3 credits each of biology and earth science. It is also recommended that students who are not already CPR certified take EDHL 2564, Standard First Aid and CPR.

Prospective students are asked to complete a “Science Teacher Education Program” application during the first semester of their senior year. Students should also apply to the Graduate School and may be considered for dual status admission during the last semester of undergraduate coursework. The application deadline is October 15 for spring admission and February 15 for summer/fall admission. For further information contact Professor George Glasson, 321 War Memorial Hall, 231-8346.

PRE-PHARMACY PREPARATION

The pre-pharmacy advisors for chemistry majors are

Dr. Gary Long	230 Davidson	231-7575	glong@vt.edu
Dr. Carla Slebodnick	011 Davidson	231-1848	slebod@vt.edu

A Bachelor's degree is not required for most pharmacy schools. On completing all admission requirements, a student may apply and be accepted to a pharmacy school. Pursuing this path does not grant a student a Virginia Tech degree. It is possible to complete the B.A. chemistry degree requirements by spending three years at Virginia Tech, matriculating in a pharmacy school, and transferring credits back to Virginia Tech. Note though that the Undergraduate Catalog states,

"All students earning degrees from Virginia Tech must have earned a minimum of one-fourth of the credit for their respective degrees from this institution. The senior year, with a minimum of 27 hours, must be completed in residence, or 27 of the last 45 hours must be completed in residence, provided that only approved courses taken *in absentia* are transferred to complete requirements."

Pharmacy school entrance requirements may vary from program to program. Students should contact individual program offices (for example, at VCU,) to confirm program-specific requirements. Here is an example of courses a Chemistry major might need to add to meet a pharmacy school's requirements:

- biology with lab (8 cr)
- chemistry with lab (8 cr)
- physics with lab (8 cr)
- English (6 cr)
- mathematics (6 cr)
- public speaking (3 cr)
- ethics (3 cr)
- electives from the social sciences and humanities (18)

For more information, please visit the American Association of Colleges of Pharmacy website: <http://www.aacp.org/>

PRE-MED AND PRE-DENTAL PROGRAMS

The Pre-Med & Pre-Dental Advisor in the Chemistry Department is Dr. Michael Berg (221 Davidson Hall). Virginia Tech also maintains a separate office for Pre-Med/Pre-Dental advising in Hillcrest Hall. This office functions within the University Honors Program; however, enrollment in the Honors Program is not a prerequisite for consultation with Pre-Med/Pre-Dental advising services. The University's Pre-Med/Pre-Dental office operates under the direction of Dr. Sitz.

Students who wish to go to medical or dental school will meet minimum admission requirements for most schools by adding freshman biology to either (B.A. or B.S.) Chemistry degree program. However, most students take additional biology and biochemistry courses. For an orderly progression through these courses, it is important that pre-med and pre-dental students take biology in their freshman year.

The next page shows a suggested program of study for chemistry students who plan to go to medical school. Pre-dentistry would be very similar. This program should be suitable for most schools, but specific entrance requirements should be examined in the book Medical School Admission Requirements: United States and Canada. A copy of this book is available in the University's Pre-Med/Pre-Dental office in Hillcrest Hall.

Nationwide, the ratio of applicants to seats for first year students has been about 2.8:1 for the past four years. Virginia Tech students have a comparable success rate of 35 percent. These data suggest that the highly successful Virginia Tech graduate is well respected as an applicant.

The Pre-Med/Pre-Dental Advising office provides direct counseling and assistance to students about careers in medicine or dentistry, preparing for application to medical or dental school, and the admission process. A course, "Careers in Medicine," is available to students at the sophomore and higher level. After gaining individual volunteer experience, a limited number of students may be placed with local physicians for a one semester two credit preceptorship. Upon request, this office will also provide interviews and letters of evaluation.

In addition to offering a Pre-Med/Pre-Dental orientations the first week of classes, the Pre-Med/Pre-Dental office maintains a FAQ online for interested students:
http://www.univhonors.vt.edu/html/premed_faq.html.
Please call the Pre-Med office at (540) 231-4591 to schedule an appointment with Dr. Sitz. Individual appointments are available Friday mornings and all day Tuesday.

CHEMISTRY B.A. for PRE-PROFESSIONAL Students

SUGGESTED COURSE SEQUENCE

First Year		Fall	Spring
CHEM 1055, 1056	General Chemistry for Chem Majors	4	4
CHEM 1065, 1066	General Chemistry for Chem Majors Lab	1	1
BIOL 1105, 1106	Principles of Biology	3	3
BIOL 1115, 1116	Principles of Biology Lab	1	1
ENGL 1105, 1106	Freshman English	3	3
MATH 1015, 1016	Elementary Calculus I	3	3
	Semester Total	15	15
Second Year			
CHEM 2565, 2566	Principles of Organic Chemistry	3	3
CHEM 2545, 2546	Organic Chemistry Lab	1	1
CHEM 4014 [†]	Survey of Chemical Literature	-	1
BIOL 2604	General Microbiology	3	-
BIOL 2004	Genetics	-	3
MATH 2015, 2016	Elementary Calculus II	3	3
PHYS 2205, 2206	General Physics	3	3
PHYS 2215, 2216	General Physics Lab	1	1
	Electives [‡]	3	-
	Semester Total	17	15
Third Year			
CHEM 2154	Analytical Chemistry for Chem Majors	4	-
CHEM 2164	Analytical Chemistry for Chem Majors Lab	1	-
CHEM 4424	Descriptive Inorganic Chemistry	-	3
BCHM 4115, 4116	General Biochemistry	4	3
STAT 3615	Biological Statistics	-	3
	Electives [‡]	6	6
	Semester Total	15	15
Fourth Year			
CHEM 4615, 4616	Physical Chemistry for Life Sciences	3	3
CHEM 3625	Physical Chemistry Lab	-	1
	Electives [‡]	12	9
	Semester Total	15	13

Students desiring a second major in biochemistry will need to take BIOL 2614 (1 cr.) and BCHM 2144 (1 cr.) in the sophomore year, and BCHM 4124 (6 cr.) in their senior year. Refer to the Biochemistry Dept website for updated information (<http://www.biochem.vt.edu/undergraduate.php>).

Other electives should be chosen after consultation with the pre-med advising office (http://www.univhonors.vt.edu/html/premed_intro.html /). Students interested in pharmacy school can follow this sequence being sure to take other required electives, e.g., microeconomics and public speaking, per admission requirements of the pharmacy schools of interest.

Useful Information from the Undergraduate Catalog

The following information is a general summary of many academic policies. **Refer to the complete text in the Undergraduate Course Catalog (<http://www.undergradcatalog.registrar.vt.edu/>) for full details.**

ACADEMIC ELIGIBILITY POLICY

A GPA of 2.0 (a C average) overall and in-major is required for graduation. Any time your overall GPA falls below 2.0 you are placed on academic probation. A student on probation may take no more than 16 credits per semester. Probation is lifted when the cumulative GPA rises to 2.0. See the Undergraduate Catalog for full requirements and conditions leading to academic suspension.

REGISTRATION FOR CLASSES

Course Request (pre-registration) is an eight-day period in the middle of each semester during which students enrolled currently may select classes for the following semester. During the spring, students register for both the summer school (if they plan to attend) and for the next fall. Plan your schedule, consult with your advisor, and go online to Hokie SPA and register.

COURSE LOADS

A student is classified as "full-time" if enrolled for 12 credit hours or more. A normal course load is 15-17 hours. Overloads (more than 19 hours per semester, 7 each summer session) require permission of your academic Dean's office. Unless such permission has been obtained in advance, you will not be able to add more than 19 credits of courses in Hokie SPA during course request or during Drop/Add.

LATE ADDS

Adding a course to your schedule after the deadline requires permission of your Academic Dean.

CLASS LEVEL

A student must have received credit for at least 30 hours to be classified as a sophomore, at least 60 hours to be classified as a junior, and at least 90 hours to be classified as a senior.

ENROLLMENT IN GRADUATE COURSES

With permission of the instructor, chemistry majors may enroll in 5000-level chemistry courses. Chemistry majors wishing to take 5000-level courses in other departments must have the approval of the instructor and the Dean of the Graduate School. In this latter case, a form letter of request is prepared, and delivered to the Graduate School. They, in turn, will register the student in the desired class.

PASS-FAIL GRADE OPTIONS

Students may take certain courses on a pass-fail basis, according to the following regulations:

1. **No college core requirements or departmental requirements may be taken under the pass-fail option.**
2. Minimum credit hours already passed on graded courses must equal 30 with a minimum GPA = 2.50. (Does not apply for courses offered only on a pass-fail basis.)
3. Maximum number of pass-fail credits allowed = 10% of the requirements for graduation taken at Virginia Tech. Courses taken beyond 120 hours can be taken pass-fail.
4. For courses taken pass-fail, P or F is recorded on the student's transcript and credit is given if the grade is P. If the course is failed, the "F" is considered as an "F" received under the "A-F" grading system and is included in calculation of the GPA.
5. Pass-fail courses are normally non-transferable to other institutions.
6. No more than 2 courses may be taken pass-fail in any semester unless courses are offered only pass-fail.

COURSE WITHDRAWAL POLICY

Students may drop courses prior to the drop deadline and the course is removed from your transcript. The drop deadline is announced in each semester's Timetable. A maximum of six hours (6) may be dropped beyond the normal drop deadline date during a student's academic career at Virginia Tech, subject to the following stipulations:

1. Students must formally request to drop a course by the last Friday of the semester in which they are enrolled in it.
2. Courses from which a student withdraws under the terms of this policy will appear on their transcript with a W. The W signifies that this policy was invoked; the reasons for its use are the (private) responsibility of the student.
3. A student's decision to invoke this policy is irrevocable and unappealable.
4. Withdrawals may not be employed to reduce or obviate any penalty otherwise accruing to students under the University Honor System.
5. Students may request withdrawal from any course, irrespective of the grade earned up to the point of the request.
6. To withdraw from a course, you must fill out a Course Withdrawal Form available from the College of Science Dean's office in 100 ASAB or from <http://www.cos.vt.edu/student/forms.asp>. The form must be signed by the student, your advisor, and the Dean.

REPEATED AND DUPLICATED COURSES

A course that partially or wholly duplicates another course also does not count toward graduation. Duplication of two courses does not necessarily mean that they are equivalent, rather it means that there is sufficient material overlap that credit is not allowed for both. No credit will be given toward graduation for duplicated courses nor may duplicate courses be used for GPA enhancement, unless the grade in the course already taken is a C- or less. Students may repeat courses in which they received grades of C- or below. Both grades stay on the record and figure into the overall and in-major GPA, but the course hours count only once toward graduation. Transcripts will display all hours completed whether or not they count toward graduation.

GRADUATION

You should apply for your Degree on Hokie Spa at the end of your junior year. You may then generate a DARS (degree audit record system) report in Hokie Spa to review your record to see what requirements for your major remain to be completed for graduation. DARS will list the courses you have yet to take, if any, and any deficiency in your GPA. Making application early ensures that you will have time to take courses that you may have overlooked, and it allows you and your advisor to correct the Registrar's analysis if errors are present. Finally, you should be advised that the Registrar's graduation analysis is not a binding contract. Do not assume that you are excused from a required course on the basis of error in DARS. The Registrar will eventually find the mistake and you will not graduate.

TRANSFER CREDIT

Students transferring to Virginia Tech from a community college may transfer as many as 60 credits. Those who transfer from a four-year college have no such limitation. However, all students graduating from Virginia Tech must complete at least 27 hours in residence. A student must take at least 27 of their last 45 hours at Virginia Tech. Also, chemistry majors and minors must take at least 25% of the required chemistry courses at Virginia Tech.

More information is available online at the University Registrar's website: <http://www.registrar.vt.edu>. Transfer students should also review the information in the online Transfer Guide: (<http://www.registrar.vt.edu/tranguide/>).

Students frequently wish to take summer school courses at other institutions for transfer back to Virginia Tech. The student should contact the college or university they wish to attend to determine what courses will be offered. An "Authorization to Take Courses Elsewhere" form should be obtained in the College of Science's Dean's office or from <http://www.cos.vt.edu/student/forms.asp> and completed (indicating the courses to be taken and the Virginia Tech courses for which credit is requested). The form must be returned to the Dean's office at least three weeks before matriculation at the other institution. Students who wait until the last part of the Spring semester to file this form may experience some delay. The transcript evaluator will determine whether the desired courses will transfer as expected, and approved copies are sent to the student and the advisor. After the courses are completed, the student must request that an official transcript be sent to the University Registrar at Virginia Tech. The evaluation will be processed as described above.

1. Students on academic suspension or disciplinary suspension may not transfer courses taken during the period of suspension even if an "Authorization" is issued before Spring grades are known.
2. Submission of an "Authorization" form does not commit the student to taking all or even any of the courses indicated. Filing the form does provide the student with the safeguard of knowing exactly how the proposed courses will transfer.
3. A student may take summer school courses without "authorization"; however, this often leads to unwanted surprises when the transcript is evaluated.
4. A letter of good standing will be mailed (when appropriate) to every institution which the student indicates an intention to attend.
5. Students in any sort of academic difficulty should consider carefully before taking summer courses elsewhere and seek advice since such action may alter their eligibility level without improving their academic record.
6. Official transcripts for work done elsewhere by continuing students must be submitted for evaluation to the University within two semesters of completing the work. Failure to do so will result in no credit granted.
7. Credits will not transfer if the grade received is C- or lower. Courses taken pass/fail will not transfer.

DOUBLE MAJORS and SECOND DEGREES

Students who complete the requirements for two majors within the same academic term are considered Double Majors. Students receive a diploma for their primary major (degree) and a double major certificate for your secondary major (double major).

Students may complete the requirements for a Second Degree in a different academic term. Students pursuing a Second Degree must complete an additional 30 credits over the minimum required for their first degree. Students will receive a separate diploma for each degree.

You should indicate on your Application for Degree on Hokie SPA if your secondary major should be a double major or a second degree under the section "What degree is this?" (Please note that if you will be completing your second degree in a later term than the first degree you will select "first degree for both majors.")

MINORS

Any department that offers a major may offer a minor. If you desire a minor in a particular subject, contact the appropriate department for their requirements or ask your advisor. Note that Majors and Minors must be added before senior year.

DEPARTMENTS THAT TEACH CHEMISTRY-RELATED COURSES

Here is a partial list of departments on campus that teach courses related to chemistry. You might find an elective to take from their course offerings, or you might even find a program suitable for a second major or minor.

Biochemistry - Biochemistry; Biotechnology (3114 Fall, 4115 Fall, 4116 Spr, 5124 Fall)
Biology – Molecular Biology (4634 Spring)
Biomedical Sciences (Vet School) Pharmacology (4074 Fall)
Chemical Engineering - Materials courses (4104, 4214, 4304)
Civil Engineering - Environmental Chemistry (5104 Fall)
Computer Science - "Methods" courses (1344, 2704, 3414)
Crop & Soil Environmental Sciences – Soil & Groundwater Pollution (4734 Fall)
Food Science & Technology - Food Chemistry (4504 Fall)
Geological Sciences - Environmental and Organic Geochemistry (4634 Spr, 4644 Spr)
Materials Science & Engineering - Materials Chemistry; Polymer Engineering (4554 Spr)
Mathematics - "Methods" courses (3414, 4404, 4554, 4445, 4446)
Physics - Chemical Physics, Solid State, Nuclear Physics, etc. (4205, 4206, 4455, 4456, 4554)
Statistics - "Methods" courses (3005, 3006)
Wood Science & Forest Products - Wood Chemistry (3434 Spr, 5414 Fall)

CURRICULUM FOR LIBERAL EDUCATION (CLE) & UNIVERSITY AND COLLEGE OF SCIENCE REQUIREMENTS

1. No more than 60 hours in the major may be counted towards the total number of hours required for graduation.
2. Successful completion of English 1105 and 1106, or 1204H. Students who receive Advanced Standing (with credit) for 1105 take only 1106. An AP English score of 3 earns credit for 1105; a score of 4 or 5 earns credit for 1105 and 1106. Students entering in Fall 1999 and thereafter must complete two (2) writing intensive courses. CHEM 3626, CHEM 4014 and CHEM 4024 are classified as writing intensive courses.
3. Proficiency in a foreign language equivalent to one year of university instruction. This requirement can be met in several ways:
 - 3.1. Completing the third year (Level III) of a language in high school.
 - 3.2. Completing the 1106 course in Chinese, French, German, Greek, Italian, Japanese, Latin, Portuguese, Russian, or Spanish, including any prerequisites.
NOTE: Students who have not completed two years of a single foreign language in high school may not count these hours toward the 120 required for graduation.
 - 3.3. A score of 500 or more on the CEEB Achievement Test.
 - 3.4. Passing an oral examination in a language not taught at Virginia Tech.
4. Six (6) hours of humanities (Area 2).
5. Six (6) hours of social sciences (Area 3).
6. Three (3) hours of fine arts (Area 6).
7. Three (3) hours: Critical Issues in a Global Context (Area 7). Some Area 7 courses may also count for Areas 2 or 3.
8. No course may be used to fulfill more than one core area, except for Area 7 courses.
9. Virginia Tech's Curriculum for Liberal Education handbook is available online:
<http://www.cle.prov.vt.edu/guides/2007-2008.pdf>.

United States History Requirement: Due to limitation in available resources, the U.S. History graduation requirement is waived for current students.

THE HONORS PROGRAM

For those students who wish to pursue enhanced undergraduate education, the University Honors Program provides a linkage to the following opportunities: priority registration, special Honors colloquia and Honors section of core classes; the development of an amplified curriculum; access to and assistance in application to major national scholarship programs for advanced undergraduate and graduate education; small group interaction with faculty; and other academic benefits. Currently almost 1600 students on campus participate.

Entering freshmen are invited to apply to University Honors if the high school GPA is at least a 3.50 and the SAT I score is a 1400 (minimums: 620 Verbal, 600 Math) or above; or if the high school GPA is at least a 3.70 with an SAT I score of 1300-1399 (minimums: 620 Verbal, 600 Math).

Transfer Students: Students who have completed one or more semesters at Virginia Tech or another college may participate in the program if they have a cumulative GPA of 3.50 or above. The Application process for University Honors requires the Application Form, Personal Statement, Curriculum Vitae, and an Official Transcript from your present college.

A student may choose from two different ways of participation.

1) COMMONWEALTH SCHOLAR DIPLOMA. The Commonwealth Scholar Program is designed for those students who achieve high levels of academic performance but whose participation in Honors education must be limited. The requirements are:

- (a) maintaining an overall 3.5 GPA;
- (b) completing 12 hours of honors courses (only one course at the 1000/2000 level), Honors colloquia, or graduate courses;
- (c) filing the necessary form in the Honors Office, first floor of Hillcrest Hall.

Upon graduation, these students receive the special "Commonwealth Scholar" diploma.

2) "IN HONORS" DEGREE PROGRAM. The degree "In Honors" signifies that a student has performed at a very high level while accepting the challenge of more rigorous requirements. The requirements for this program are:

- (a) maintaining an overall 3.6 GPA;
- (b) filing the candidacy form in the Honors Office, first floor of Hillcrest Hall;
- (c) completing 12 hours of Honors courses (only one course at the 1000/2000 level), Honors colloquia, or graduate courses;
- (d) taking 6-9 hours of undergraduate research with a professor in your major (mentor) with a grade of A-F;
- (e) turning your thesis (or paper) into the Honors Office with a written approval of your mentor 2 weeks before graduation. Approval would ordinarily follow the successful defense of the thesis before a committee of three chemistry faculty at an oral examination. Alternately the student may choose a public presentation of the work at a scientific meeting. The Chemistry Department must approve the meeting, and the paper must be submitted to the University Honors Program. A special "In Honors" diploma is awarded upon graduation.

Students in both categories have the option of taking 2000-level chemistry courses and above on a tutorial basis, upon the approval of the academic advisor and the instructor in the course. For courses taken on this basis, class attendance will be optional and regular homework assignments, tests and examinations will not be required. Regular conferences will be set up between the instructor and the student. The subject matter of the course will be studied on a tutorial basis, and related subjects will be explored as the instructor and student deem appropriate. The student will be evaluated by the instructor on the basis of the work done and a letter grade will be assigned.

Students who wish to join the Honors Program should contact Prof. Charles Dudley, Director, University Honors Program, Hillcrest Hall, <http://www.univhonors.vt.edu/>.

UNDERGRADUATE RESEARCH (CHEM 4994)

Chemistry majors are encouraged to undertake a research project in collaboration with at least one faculty member. Credit for this activity is obtained by enrolling in CHEM 4994 for those semesters (including summers) in which the work is to be performed. Chemistry faculty can suggest either short-term (one semester) or long-term projects; in every case, undergraduate research projects are designed to meet the individual interests and needs of the student. An interested student should consult with a prospective research mentor at least several weeks prior to the semester to do the research. More information and a listing of faculty available for Undergraduate Research is available on the Chemistry undergraduate pages: <http://www.chem.vt.edu/undergrad/research.html>.

INDEPENDENT STUDY (4974)

Courses generally involve extensive reading and tutorial sessions with the faculty supervisor and also may involve written papers. The subject of independent study usually is a continuation in greater depth of a topic covered in a regular course, allowing students to study topics of particular individual interest. A student must have at least a 2.5 GPA overall and in the major and sophomore standing, in order to request Independent Study.

NO MORE THAN 8 SEMESTER HOURS OF INDEPENDENT STUDY OR UNDERGRADUATE RESEARCH MAY BE COUNTED TOWARD A DEGREE.

Miscellaneous Student Information

AWARDS

There are a number of student awards given to chemistry majors during their student careers. Awardees are selected by the Chemistry Department faculty each year. There is no application process. For further information, check with the Director of Undergraduate Studies.

SCHOLARSHIPS

Chemistry majors are eligible for a number of scholarships. To be eligible for some “need-based” scholarships, you must complete a Financial Aid Form and be certified by the Financial Aid Office to have “need.” Merit scholarships are awarded by the Department of Chemistry to majors with superior academic records. For further information, check <http://www.chem.vt.edu/undergrad/>.

ALPHA CHI SIGMA & CHEMISTRY CLUB

There are two student groups affiliated with the Chemistry Department at Virginia Tech: Alpha Chi Sigma, the co-ed professional chemistry fraternity, and the Chemistry Club, a student affiliate chapter of the American Chemical Society. All chemistry majors are encouraged to join one and/or both of these groups. Activities include meetings, socials, tutoring, and hosting “illusion shows” and an end-of-the-year picnic for the department. For further information, please visit

<http://www.chem.vt.edu/undergrad/chem-clubs.html>.

AFTER GRADUATION?

After receiving the B.S. or B.A. degree in chemistry, some students continue their education in professional or graduate school, and some take an entry-level job in chemistry or a related discipline.

Professional School Opportunities. Chemistry graduates may choose to pursue careers in dentistry, law, medicine, optometry, pharmacy, veterinary medicine, etc. Your academic advisor can direct you to numerous sources of information concerning professional school.

Graduate School. Many companies prefer to hire scientists with advanced degrees.

B.S. and B.A. chemists are qualified to enter graduate school and pursue the M.S. or Ph.D. degree in a surprisingly large number of areas, some of which we have listed below:

chemistry	biochemistry	chemical engineering
textiles	paper chemistry	environmental engineering
food science	toxicology	medicinal chemistry
pharmacology	pharmacy	materials engineering
microbiology	virology	forensic chemistry
oceanography	clinical chemistry	secondary education

Your academic advisor should be able to advise you concerning graduate school, particularly in chemistry. If you are interested in an area unfamiliar to your advisor, he should be able to direct you to someone knowledgeable. Students wishing to go to graduate school should plan to take the Graduate Record Exam (GRE) in the fall of their senior year, and should complete their applications in mid-January.

Employment. Finding a job requires work, perseverance, and a little luck, so you should plan to spend considerable time and effort in your search. If you sit back and wait for employers to come to you, you will not find a job! There are three sources of help for students interested in finding employment immediately after graduation: your academic advisor, the departmental career advisor, and the Office of Career Services, <http://www.career.vt.edu/>. This office provides an Information Center with materials such as directories, employer literature and video tapes, salary information, weekly job listings, etc. They offer services such as individual advising sessions, group meetings and seminars, and on-campus interviewing opportunities. Below is a typical list of group meetings offered:

- "Make the Most of On-Campus Interviewing"
- "How to Prepare your Personal Data Sheet"
- "An Effective Resume: Make it Work for You"
- "Sharpen your Interviewing Skills"
- "How to Find a Job with the Federal Government"
- "Finding the Job you Want: Successful Strategies"
- "The On-Site Interview: What to Expect and How to Prepare"

The Career Advisor, Dr. Brian Hanson, can give you specific advice about jobs in chemistry and related areas. Dr. Hanson can provide you with information in three areas:

- 1) what is expected of a B.S./B.A. chemist, what kind of jobs are available,
- 2) what courses are needed to prepare for a job, and
- 3) how to go about finding a job?

Two Very Important Issues

SAFETY PRACTICES AND RULES

- I. Know the location of and read the University/Chemistry Department Chemical Hygiene Plan before you start any chemical lab work. Notice in the C.H.P. the following areas in particular:
 - A) Eye protection requirements;
 - B) Glove, protective clothing and respirator use;
 - C) Chemical handling and hazardous waste procedures;
 - D) Fire extinguisher use;
 - E) Emergency procedure, evacuation instructions;
 - F) Unattended operations and working alone limitations;
 - G) Use of spill handling equipment;
 - H) Use of eye wash, fire blanket, deluge show, first aid;
 - I) Telephone numbers for emergency services (fire, police, rescue) and university safety office services;
 - J) General housekeeping instructions;
 - K) Any special hazardous work procedures or protocols;
 - L) Any other pertinent areas to the type of work you may be asked to do.
- II. Ask questions and get information on any areas of lab operations that you do not feel well trained to do. Do not work without supervision until trained to do so.
- III. Safety information, including emergency contacts, first aid and technical literature, is available on the Chemistry Department Safety webpage: <http://www.chem.vt.edu/about/safety/>.
- IV. Emergency telephone number: **911** for Virginia Tech police who will dispatch all other services, if needed.

NOTE: Do not work with or clean up any chemicals for which you do not know the hazards. Do not work on or repair any equipment with which you are not familiar.

UNIVERSITY COUNSELING CENTER

The Cook Counseling Center at Virginia Tech is staffed with licensed psychologists and professional counselors. They are available for individual counseling for students experiencing difficulties such as depression, anxiety, loneliness, sexual concerns, couples issues, and problems studying. They also offer group counseling programs. Topics vary from term to term, but typically there would be sessions on interpersonal relationships, choosing a major, time management, test anxiety, substance abuse, and stress management. Informational on-line screening modules are also available for depression, alcohol use, eating disorders, and anxiety (visit <http://www.ucc.vt.edu/>).

Appointments can be arranged by visiting the office (240 McComas Hall) or by calling 231-6557. All enrolled undergraduate students are eligible for these services at no additional cost.

Undergraduate Courses (CHEM)

1015-1016: INTRODUCTION TO CHEMISTRY

For students enrolled in curricula other than science or engineering. Chemical principles applied to material, environmental, and life sciences. (Duplicates 1035-1036.) (3H,3C)

1025-1026: INTRODUCTION TO CHEMISTRY LABORATORY

Accompanies 1015-1016, where lab work is required in a student's curriculum. Must be taken concurrently and in phase with lecture sequence, 1015-1016. In both semesters, experiments illustrate principles covered in lecture. (Duplicates 1045-1046.) Co: 1015 for 1025; 1016 for 1026. (3L,1C)

1035-1036: GENERAL CHEMISTRY

Principles of the science, character of the elements and their more important compounds, solution of chemical problems, and important applications. (Duplicates 1015-1016.) (3H,3C)

1035H,1036H: GENERAL CHEMISTRY

More in-depth treatment of the principles of the science, character of the elements and their more important compounds, solution of chemical problems, and important applications. (Duplicates 1015-1016) (3H,3C)

1045-1046: GENERAL CHEMISTRY LAB

Accompanies 1035-1036. Selected experiments illustrate principles taught in lecture. (Duplicates 1025-1026). Co: 1035 for 1045; 1036 for 1046. (3L,1C)

1055-1056: GENERAL CHEMISTRY FOR CHEMISTRY MAJORS

In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry majors. Co: 1065 for 1055; 1066, 1066 for 1056. (4H,4C)

1055H-1056H: HONORS GENERAL CHEM FOR MAJORS

More in-depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry majors.

Co: 1065 for 1055H; 1066, 1066 for 1056H. (4H,4C)

1065-1066: GENERAL CHEMISTRY FOR CHEMISTRY MAJORS LAB

Accompanies 1055-1056. Selected experiments illustrate principles taught in lecture. This class is restricted to chemistry majors. Co: 1055 for 1065; 1056 for 1066. (3L,1C)

2114: ANALYTICAL CHEMISTRY

A first course in analytical chemistry. Topics covered include volumetric and gravimetric analysis, and elementary spectroscopy. Pre: 1036 or 1056. Co: 2124. (3H,3C)

2124: ANALYTICAL CHEMISTRY LABORATORY TECHNIQUES AND PRACTICE

Practical introduction to wet methods of quantitative chemical analysis based on fundamental chemical principles. CHEM 2124 may be substituted for CHEM 3124. Pre: (1046 or 1066), 2114. Co: 2114. (3L,1C)

2154: ANALYTICAL CHEMISTRY FOR CHEMISTRY MAJORS

A one-semester course in analytical chemistry emphasizing the principles of equilibrium with examples from acid-base, complexation, solubility, and redox chemistry. The course also introduces the principles of spectroscopic, electrochemical, and chromatographic instrumentation. Pre: 1036 or 1036H or 1056 or 1056H. Co: 2164. 4H,4C)

2164: ANALYTICAL CHEMISTRY FOR CHEMISTRY MAJORS LAB

A one-semester laboratory course in analytical chemistry that provides practical training in wet chemical methods, atomic and molecular spectroscopy, electrochemistry, and separations. Pre: 1046 or 1066. Co: 2154. (3L,1C)

2424: DESCRIPTIVE INORGANIC CHEMISTRY

Application of fundamental principles in a systematic study of bonding and reactivity of the elements and their compounds. Pre: 1036 or 1056. (3H,3C)

2514: SURVEY OF ORGANIC CHEMISTRY

Short course in fundamentals of organic chemistry with emphasis on nomenclature, isomerism, and properties of organic compounds. Compounds of importance to biology and biochemistry stressed. (Prior credit for 2535 precludes credit for this course.) One year of Chemistry required. (3H,3C)

2535-2536: ORGANIC CHEMISTRY

Structure, stereochemistry, reactions, and synthesis of organic compounds. Pre: 1036 or 1056 for 2535; 2535 or 2565 for 2536. (3H,3C)

2545-2546: ORGANIC CHEMISTRY LABORATORY

The laboratory accompanies lectures in organic chemistry 2535 and 2536. Pre: 1046 or 1066 for 2545; 2545, (2536 or 2566) for 2546. Co: 2535 or 2565 for 2545; 2536 for 2546. (3L,1C)

2555-2556: ORGANIC SYNTHESIS AND TECHNIQUES LAB

Synthesis and characterization of organic compounds using modern laboratory techniques. II Pre: 2566 for 2555; 2555 for 2556. (6L,2C)

2565-2566: PRINCIPLES OF ORGANIC CHEMISTRY

Organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses. Pre: 1036 or 1056 for 2565; 2565 for 2566. (3H,3C)

2565H-2566H: PRINCIPLES ORG CHEM

More in-depth treatment of organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses. (3H,3C)

2964: FIELD STUDY

Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY

Variable credit course.

2984: SPECIAL STUDY

Variable credit course.

3615-3616: PHYSICAL CHEMISTRY

Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partially duplicates 4615, cannot receive credit for both 3615 and 4615. I,II,III. Pre: (1036 or 1056), PHYS 2306, MATH 2224 for 3615; 3615, 1036, MATH 2214, (PHYS 2306 or PHYS 2176) for 3616. (3H,3C)

3615H-3616H: HONORS PHYSICAL CHEMISTRY

More in-depth study of principles of thermodynamics, kinetics, and quantum mechanics as applied to chemical equilibria, reactivity, and structure. Partially duplicates 4615, cannot receive credit for both 3615H and 4615. 3615H requires additional work; consult the instructor. I,II,III Pre: 1036, (PHYS 2306 or PHYS 2176) for 3615H; 3615, 1036, MATH 2214, (PHYS 2306 or PHYS 2176) for 3616H. (3H,3C)

3625-3626: PHYSICAL CHEMISTRY LABORATORY

Laboratory study of selected physico-chemical principles and methods. Data acquisition, data analysis, and report writing are stressed. I,II Pre: 3615 or 4615 for 3625; 3616, 3625 for 3626. (3L,1C)

4014: SURVEY OF CHEMICAL LITERATURE

Use of the chemical literature as an aid to professional activities. I,II (1H,1C)

4074 (MSE 4544): LABORATORY IN POLYMER SCIENCE

Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems. Graduate students in chemistry, P/F only. Pre: 3616, 4534. (1H,3L,2C)

4114: INSTRUMENTAL ANALYSIS

Principles of instrumental methods including data analysis, phase equilibrium, spectroscopy, and electrochemistry. Applications of modern instrumentation to chemical analyses using chromatography, electrophoresis, atomic and molecular spectroscopy, potentiometry, and voltammetry. Note: Graduate students will not be expected to take the corequisite lab 4124. Pre: 3616. Co: 4124. (3H,3C)

4114H: HONORS INSTRUMENTAL ANALYSIS

More in-depth treatment of principles of instrumental methods including data analysis, phase equilibrium, spectroscopy, and electrochemistry. Applications of modern instrumentation to chemical analyses using chromatography, electrophoresis, atomic and molecular spectroscopy, potentiometry, and voltammetry. Note: Graduate students will not be expected to take the corequisite lab 4124. Pre: 3616. Co: 4124. (3H,3C)

4124: INSTRUMENTAL ANALYSIS LABORATORY

Hands-on experience with modern instrumental methods of analysis. Experiments use spectroscopy, electrochemistry, and separations. Co: 4114. (3L,1C)

4404: PHYSICAL INORGANIC CHEMISTRY

A study of spectroscopic, bonding, and structural properties of inorganic compounds. I Co: 3616. (3H,3C)

4414: INORGANIC CHEMISTRY LAB

Synthesis and characterization of inorganic compounds using modern laboratory techniques. II Pre: 4404. Co: 4424, 3616. (6L,2C)

4514: GREEN CHEMISTRY ****NEW COURSE****

Green chemistry applies the principles of *prevention* of toxic and hazardous waste, and energy efficiency to real world chemical products and processes. Emphasis is on case studies, problem solving, and life cycle analysis. Pre: 2536 or 2566 (3H,3C).

4524: IDENTIFICATION OF ORGANIC COMPOUNDS

Structure determination of organic compounds by spectroscopic methods, with an emphasis on mass spectrometry and nuclear magnetic resonance. Course will emphasize problem-solving skills. I. Pre: (2536 or 2566), (3616 or 4616). (3H,3C)

4534: ORGANIC CHEMISTRY OF POLYMERS

Structure, synthesis, and basic characteristics of the major classes of polymerization reactions including step-growth (condensation) and chain growth (addition), free radical, and ionic mechanisms. Pre: 2536 or 2566. (3H,3C)

4554: DRUG CHEMISTRY

Structure, synthesis, and physiological effects of major classes of pharmaceutical agents including CNS depressants and stimulants, analgesics, anesthetics, cardiovascular agents, chemotherapeutic drugs, and oral contraceptives. II Pre: 2536 or 2566. (3H,3C)

4615-4616: PHYSICAL CHEMISTRY FOR THE LIFE SCIENCES

Principles of thermodynamics, chemical kinetics, and chemical bonding for students in the life sciences. 4615: Laws and applications of thermodynamics. 4616: Chemical kinetics and chemical bonding including spectroscopy. Partly duplicates 3615, cannot receive credit for 3615 and 4615. Pre: One year of chemistry, physics, and calculus. (3H,3C)

4634 (MSE 4534): POLYMER AND SURFACE CHEMISTRY

Physical chemical fundamentals of polymers and surfaces including adhesives and sealants. II Pre: 3615 or 4615. (3H,3C)

4654: ADHESIVE AND SEALANT SCIENCE

Introduction to the fundamental and practical aspects of adhesives and sealants. Emphasis on synthesis of polymeric adhesive and sealant molecules, determination of physical properties of adhesives and sealants, chemical and physical characteristics of adherend surfaces, and mechanical behavior and durability of bonded systems – including metals, composites, polymers, and wood. I Pre: (3615 or 4615). (3H,3C)

4734 (CSES 4734) (ENSC 4734): ENVIRONMENTAL SOIL CHEMISTRY

Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes. Pre: CSES 3114, CSES 3124, CHEM 2514 or CHEM 2535, CHEM 3114, MATH 2015. (3H,3C) I.

4754 (CSES 4754) (ENSC 4754): INSTRUMENTAL ANALYSIS FOR AGRICULTURAL AND ENVIRONMENTAL SCIENCES

Theory and principles of common analytical instruments and their applications to agriculture and environmental science research. Topics include atomic absorption and emission spectroscopy, spectrophotometric methods (UV, visible, luminescence, and automation), chromatography, ion-selective electrodes, and microwave digestion. Infrared spectroscopy, atomic ratio and molecular mass spectroscopy, nuclear magnetic resonance will also be included. Provides hands-on experience with modern analytical instruments. Prerequisites or graduate standing required. II Pre: (3114, 3124) or (CSES 3114, CSES 3124). (3H,3L,4C)

4964: FIELD STUDY

Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY

Variable credit course.

4984: SPECIAL STUDY

Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH

Variable credit course.