

## Chemistry

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### Introduction

Chemistry is the science concerning the control, properties, reactivity, and detection of atoms and molecules in the world around us. Just as chemistry contributes to our existence, culture, and quality of life, the discipline of chemistry is a central science, with new frontiers continually being explored from which new benefits result. The Department serves the entire student population in addition to chemistry majors in a well-equipped state of the art facility that is part of the TCNJ Science Complex. Consistent with the goals of TCNJ, the chemistry faculty has substantial contact with each student. Faculty advisors meet regularly with students to assist in defining educational paths that will best allow the pursuit of career goals. Student development is enhanced through a seminar program, which includes discussions of the roles and responsibilities of chemists in today's society. Additionally, students have the opportunity to participate in research with faculty members in each of the sub-disciplines of chemistry.

Many TCNJ chemistry majors pursue advanced degrees in analytical, forensics, organic, inorganic, physical chemistry, or biochemistry at leading graduate programs throughout the country. Graduates are also well-prepared for entrance into dental, medical, and other professional schools. The program trains students for careers working in the chemical industry, as educators, and in careers at state and national government laboratories.

By combining the chemistry degree with an appropriate minor, students will also be well prepared to pursue careers that rely on a peripheral knowledge of chemistry. For example, students interested in pursuing a career in pharmaceutical sales and marketing can combine a major in chemistry with a minor in marketing. Chemistry specializations in Forensic Chemistry and the Chemistry and Physics of Condensed Matter are available as well, to further broaden the chemistry background of TCNJ students.

The Chemistry Department has a strong sense of community with a Student Chemist's Association (part of the ACS Student Affiliates) and a chapter of the National Chemistry Honor Society (Gamma Sigma Epsilon). Students completing the chemistry major will receive a Bachelor of Science degree. Students planning to pursue a career in chemistry or allied fields are strongly encouraged to complete the requirements for an American Chemical Society certification.

Those students wishing to earn an honors designation in chemistry may do so by successfully completing a series of ACS examinations and a research project.

### **Recommended High School Preparation**

A curriculum that develops and sharpens problem-solving and critical thinking skills is paramount. Based on the interdisciplinary nature of modern chemistry, a good level of preparation for an entering chemistry major at TCNJ includes one year each of college preparatory or AP-level chemistry, physics, and biology. The quantitative nature of chemistry requires a solid mathematics background including algebra, geometry, trigonometry, and calculus, if available. Experience with word processing, spreadsheets, and presentation software is helpful, as is coursework or outside experience in computer programming. Four years of English that provide solid writing skills are also desirable. Since graduate study in chemistry toward a PhD degree often requires a reading knowledge of a modern foreign language, foreign language study should begin in high school.

### **General Department Policies for All Students**

#### **A. AP Scores**

Students select all courses in consultation with their academic advisor and/or the department chair. An AP score of 4 garners credit for CHE 201, General Chemistry I. An AP score of 5 results in credit for both CHE 201 and 202, General Chemistry I and General Chemistry II. While students with a chemistry AP score of 5 may receive credit for CHE 202, the Department strongly recommends that students take CHE 202 or HON 202 before enrolling in higher-level chemistry courses. We make this recommendation for the following reasons: 1) many students take AP chemistry their junior year in high school and find that they have forgotten much of the material by their freshman year in college, 2) higher-level chemistry courses expect a high level of competency in the lab that is normally gained in CHE 201 and 202, 3) freshman year is a period of adjustment and many freshmen lack the maturity and the study skills required for upper-level chemistry courses, and 4) our experience is that freshmen who take Organic Chemistry I or Analytical Chemistry their first semester at TCNJ generally perform poorly in these courses.

#### **A. Repeating a Course**

Students may repeat any course in chemistry, with the following provisions. A student may be exempted from repeating the laboratory component of a foundation course if the course was passed with a grade of D or better and the lab average was 80% or better. The lab component must be repeated regardless of the lab average if a student wishes to repeat a course they failed. For upper level chemistry courses, this policy is at the discretion of the instructor.

There is a limit to the number of times a student can repeat courses in chemistry. Students may register for a course no more than two times, whether a 'W' or letter grade is received. Exceptions to this rule may only be granted by the department chair and only under extenuating circumstances, such as a severe illness or the death of a family member while taking the chemistry course.

### C. Progression in the Chemistry Course Sequence

Enrollment in CHE 201, CHE 202, CHE 310, CHE 331, and CHE 332 requires that the student have a minimum grade of C- in the pre-requisite courses (see Table, below). The Chemistry Department has found that students with grades lower than C- in pre-requisite courses will struggle significantly in the subsequent course. If, after semester grades have been issued, a student discovers that he/she will not meet this requirement, they must de-register for the subsequent course (for example, a student who has registered for CHE 202 but completes CHE 201 with a grade of D+ must de-register from CHE 202 and repeat CHE 201). The Chemistry Department has the authority to de-register students who have not met course pre-requisites. Please note that any student enrolled in courses with improper grade pre-requisites is in violation of the Student Conduct Code.

To enroll in	A minimum grade of C- is required in
CHE 202	CHE 201
CHE 310	CHE 202
CHE 331	CHE 202
CHE 332	CHE 331

## General Departmental Policies For Chemistry Majors

### A. Chemistry Coursework

Once a student is accepted into The College of New Jersey as a Chemistry major, all of the student's chemistry courses must be completed at TCNJ, unless approval is granted by the department chair. Approval for a chemistry course substitution from another college or university will not be granted if the student has failed or withdrawn from the corresponding course at TCNJ. It is College policy that the course be repeated at The College of New Jersey to satisfy the requirement and exclude the previous grade and include the new grade, if it is better, in the calculation of the grade point average.

Transfer students are required to take a minimum of four course units of chemistry (courses numbered CHE 300 or above) in addition to other college requirements for graduation as chemistry majors from TCNJ.

### B. Program Entrance, Retention, and Exit Standards

Every major program at the College has set standards for allowing students to remain in that program, to transfer within the College from one program to another, and to graduate from a program. The following are the standards for all TCNJ chemistry programs. Minimum grades are noted in parentheses:

- 1) Retention in the program is based on the performance standards in the following "critical content courses":
  - ✓ CHE 201 General Chemistry I (minimum grade of C)
  - ✓ CHE 202 General Chemistry II (minimum grade of C)
  - ✓ CHE 331 Organic Chemistry I (minimum grade of C)

- ✓ CHE 310 Analytical Chemistry (minimum grade of C)
- 2) Students wishing to transfer into the chemistry program from another department or program at TCNJ must:
- ✓ Complete a minimum of one semester at TCNJ. This must include at least one Chemistry course.
  - ✓ A grade of C or better in all chemistry and correlate courses taken at TCNJ.

Typically, transfer students have an overall GPA of 3.0 or higher.

Note that students must fill out a *transfer of major* form and file it with the Chemistry Department office no later than October 15<sup>th</sup> in the fall semester, and February 15<sup>th</sup> in the spring semester. Admission decisions are made once a semester, prior to the registration period for the following semester. Admission is based on the number of seats available and the qualifications of the applicant.

- 3) Graduation requires a GPA of 2.0 in courses required for the major.

### Programs Within Chemistry

Students can obtain one of three possible BS degrees in chemistry, including two American Chemical Society (ACS) accredited degrees. In addition to the description of these options provided here, students should seek guidance from their academic advisors for further information. Chemistry degrees include:

- ✓ **ACS-certified BS Chemistry degree**– For students interested in working in industry at a bachelor's level, and for students pursuing advanced degrees in health, law, business, and fields requiring a working knowledge of chemistry.
- ✓ **ACS-certified BS Chemistry degree, with research**– For students interested working in industry or obtaining a graduate degree in chemistry or related fields.
- ✓ **BS Chemistry degree**– For students pursuing careers in secondary education, health related fields or interested in obtaining a double-major in another field.

In addition to the above, students can pursue the following programs and areas of specialization:

- ✓ **Forensic Chemistry Specialization.** For students interested in crime lab work, industrial forensics, analytical chemistry, and graduate programs in chemistry.
- ✓ **Chemistry and Physics of Condensed Matter Specialization.** For students interested in materials science, biophysical chemistry, nanotechnology, crystal engineering, magnetism, and related fields.
- ✓ **Chemistry Secondary Education Degree.** In conjunction with the Department of Education, students enroll in educational courses, which lead to certification in teaching chemistry at the secondary level in the state of New Jersey. Enrollment in Secondary Education must be completed no later than the second semester of freshman year in order to complete the degree in four years.
- ✓ **Seven-year BS Chemistry/MD Program.** Students majoring in chemistry and admitted as freshmen to the TCNJ/NJMS seven-year BS/MD program. See [7-Year Medical Program](#) for general information about the BS/MD program. Please note that the seven-year BS Chemistry/MD Program is an accelerated program through Rutgers New Jersey Medical School and is not the typical route to a medical degree (typically, students complete a four-year bachelor's degree in biology, chemistry, or another major prior to starting medical school; see the section below titled Pre-Health Profession Option for Chemistry Majors).

All degrees require the completion of a core curriculum, followed by additional requirements that are based on the specific degree track chosen. The following core courses are required for all TCNJ Students enrolled in the chemistry program:

<b>Chemistry Core Courses (9.5 Course Units)</b>	
CHE 201, 202/General Chemistry I, II	2 course units
CHE 310/Analytical Chemistry	1 course unit
CHE 331, 332/Organic Chemistry I, II	2 course units
CHE 371/Quantum Chemistry	1 course unit
CHE 372/Chemical Thermodynamics and Kinetics	1 course unit
CHE 430/Biochemistry	1 course unit
CHE 451/Inorganic Chemistry– Structure and Bonding	1 course unit
CHE 099, 316, 317/Chemistry Seminars	0.5 total course unit
<b>Correlate Courses (4 Course Units)</b>	
MAT 127, 128/Calculus A, B	2 course units
PHY 201, 202/Physics I, II	2 course units
<b>Options Courses<sup>a</sup> (5 or 3 Course Units)</b>	
<i>See course descriptions for prerequisites</i>	
CHE 360/Forensic Chemistry	
CHE 365/Environmental Chemistry	
CHE 410/Advanced Analytical Chemistry– Instrumental Analysis	
CHE 415/Separation Science	
CHE 452/Inorganic Chemistry– Reactions and Mechanisms	
CHE 470/Advanced Topics in Chemistry	
CHE 471/Forensic Applications of Mass Spectrometry	
CHE 474/Special Topics in Biochemistry	
CHE 476/Special Topics in Organic Chemistry	
CHE 478/Special Topics in Condensed Matter	
CHE 493/Independent Research	

<sup>a</sup> Courses outside the department (such as Genetics, Molecular Immunology and Human Disease, Mathematical Physics, Linear Algebra, or Modern Physics) can be substituted for a 300 level options course upon approval by the Department Chair.

Chemistry Degree Programs			
Chemistry Liberal Arts Degree Programs	Additional requirements beyond the core course requirements	Forensics Specialization	Chemistry and Physics of Condensed Matter Specialization
ACS certified BS Chemistry degree	One Chemistry Options 300- or 400- level course with laboratory <sup>a</sup> Two Chemistry Options 400 level with laboratory (CHE 410 is strongly recommended) <sup>a</sup>	Available option	Available option
ACS certified BS Chemistry degree, with research	One 300- or 400-level Chemistry Options course, with <i>or without</i> laboratory Two 400-level Chemistry Options courses, with <i>or without</i> a laboratory <sup>b</sup> Two units (equivalent to 4-8 total credit hours) of CHE 493 Independent Research	Available option	Available option
BS Chemistry Degree	One Chemistry Options 400-level course, with <i>or without</i> laboratory Two Chemistry Options 400- or 300-level course, with <i>or without</i> laboratory	Available option	

<sup>a</sup> All three chemistry options must have a laboratory component to complete the laboratory hours required by the ACS (400 total hours).

<sup>b</sup> A third semester of CHE 493 Independent Research may substitute for one of these courses.

Dual Degree Programs	Available Chemistry degree options	Additional requirements
Secondary Education Chemistry Degree Programs	ACS-certified BS Chemistry degree ACS-certified BS Chemistry degree with research or BS Chemistry Degree <sup>a</sup>	See full description of program, below
Seven-year BS Chemistry/MD Program	BS Chemistry Degree	See full description of program, below

<sup>a</sup> Student Teaching may be used to satisfy a 300 or 400-level Chemistry Options course.

### **1. The Forensic Chemistry Specialization (CFOR Specialization)**

The Forensic Chemistry Specialization builds on the TCNJ BS degree in Chemistry and is open to all majors in the Chemistry Department. Completion of the CFOR Program provides specialized training into the chemical aspects of the applied field of forensics chemistry. BS graduates with this specialization can pursue a wide range of careers or graduate education in Chemistry

To complete the Forensic Chemistry Specialization, students must complete the following program in addition to all requirements for the BS in chemistry program: 1) two criminology courses (CRI 200 and 203, or 201 and 203); 2) a research experience or internship in a related area is highly recommended; and 3) two Forensic Chemistry courses, CHE 360 and CHE 471. The CRI courses are considered as correlate courses to the Specialization. All Forensic Chemistry courses will have an accompanying laboratory. In addition, students completing the specialization are encouraged to attend a meeting in a related area such as the *American Academy of Forensic Sciences Annual Meeting*.

To enroll in the Forensic Chemistry Specialization, students must formally identify Forensic Chemistry Specialization (CFOR) as their specialization.

### **2. Chemistry and Physics of Condensed Matter Specialization (CPCM Specialization)**

The Chemistry and Physics of Condensed Matter Specialization is an interdisciplinary program open to chemistry and physics majors in the School of Science, who have a strong interest in creating new organic, biological, or inorganic materials and/or exploring the properties and applications of these materials. Students should have a background in chemistry and physics and be comfortable with mathematics. Chemistry students are free to pursue research projects in either the Chemistry Department or Physics Department. Chemistry majors who successfully complete this program will graduate with a Bachelor of Science in Chemistry and a specialization in the Chemistry and Physics of Condensed Matter. Students will be prepared to pursue a wide variety of careers or graduate study in chemistry, biophysics, or materials science.

To complete the Condensed Matter specialization, students must complete the following coursework in addition to all requirements for the BS in chemistry program: 1) PHY 306/Mathematical Physics or MAT 229/Multivariable Calculus; 2) PHY 311 – Analog and Digital Electronics or PHY 451 Advanced Lab or CHE 410/Instrumental Analysis; and 3) at least three of the following options courses: PHY 345/Physics of Clouds and Climate, PHY 436/Condensed Matter, CHE 451/Inorganic Chemistry I, CHE 478/Special Topics in Condensed Matter (may be taken more than once), and PHY 478/ Photonics, Optics, and Materials. See course listings for additional details. Students must complete at least one options course with a PHY prefix and at least one with a CHE prefix.

Students may apply for the specialization at any time but are encouraged to do so in their sophomore year to facilitate planning and timely completion. To enroll in the program, students should identify Chemistry and Physics of Condensed Matter Specialization (CPCM) as their second major/concentration.

### 3. Seven-year BS Chemistry/MD Program degree

Admission to this program is dependent on dual acceptance into TCNJ and Rutgers NJMS programs. Certain changes to the core chemistry curriculum have been made to allow for timely completion of the chemistry degree, including: 1) substitution of BIO 231/Genetics for one 300-level Chemistry options course with laboratory, 2) enrollment in Biochemistry at NJMS as a substitute for one 400-level Chemistry options course, and 3) enrollment in Medical Physiology at NJMS as substitute for one 400-level Chemistry options course. Students in the Seven-year BS Chemistry/MD Program should take BIO 185/Themes in Biology their first year at TCNJ.

### 4. Chemistry Secondary Education Program

The Chemistry Secondary Education program provides TCNJ students with a BS degree in Chemistry and Secondary Education certification. Students must complete the requirements for either an ACS-certified or a non-ACS certified major, as listed above. In addition to meeting the requirements for the major, the Chemistry Secondary Education student must meet the college requirements of liberal learning, the professional education sequence (see below), and state certification. This requires careful course planning with the student's academic advisor(s) starting with the first semester of classes. To be retained in the chemistry secondary education program, a student must earn at least a 2.5 cumulative grade point average (CGPA) before enrolling in the junior year education sequence and must have a 2.75 or higher cumulative grade point average to successfully complete their teacher education program. The student must also establish a minimum overall 2.75 GPA before he/she is allowed to student teach (i.e., enrollment into CHE 490). They also must meet the state hygiene/physiology requirement, the state Harassment, Intimidation, and Bullying Prevention (HIB) training certificate requirement, and pass the appropriate Praxis examination. NOTE: A student wishing to obtain Physical Science Certification must replace the CHE 300 level course with an Advanced Physics course and take a second Advanced Physics course.

Teacher-education candidates will receive a "certificate of eligibility with advanced standing" which requires a candidate to be provisionally certified for his or her first year of teaching. After one year of successful teaching, the candidate is eligible for a permanent certificate.

An overview of the entire secondary-level teacher preparation sequence for students can be found in the section of this bulletin for the [Department of Education Administration and Secondary Education](#).

<b>Professional Education Sequence (9 Course Units)</b>	
SED 224/Adolescent Learning and Development	1 course unit
EFN 299/School and Communities	1 course unit
SED 399/Pedagogy in Secondary Schools	1 course unit
PHY 390/Methods of Teaching Science	1 course unit
SPE 323/Secondary Content Literacy in Inclusive Classrooms	1 course unit
EFN 398/Historical and Political Context of Schools	1 course unit
CHE 490/Student Teaching	2 course units
SED 498/Collaborative Capstone for Professional Inquiry	1 course unit

**Recommended First-Year Sequence** (Actual courses may vary with advisement and course availability)

<b>Fall Semester</b>	<b>Spring Semester</b>
FSP/First Seminar CHE 099/Orientation to Chemistry XXX/Liberal Learning/Language <sup>a</sup> CHE 201/General Chemistry I MAT 127/Calculus A	CHE 202/General Chemistry II MAT 128/Calculus B PHY 201/General Physics I WRI 102/Academic Writing <sup>b</sup>

<sup>a</sup> It is recommended that students exempted from the language requirement take another liberal learning course. Note: Arabic 151 and 152, Chinese 151 and 152, Japanese 151 and 152, and Russian 151 and 152 are intensive courses and carry two course units of credit each. Students should take this into account when planning a normal four-course semester.

<sup>b</sup> It is recommended that students exempted from this course take another liberal learning or language course.

### **Pre-Health Profession Options for Chemistry Majors**

Students interested in health-related careers such as medicine, dentistry, pharmacy, etc. may study for admission to these professional schools through the chemistry liberal arts major. Careful selection of courses within this major and within free electives will prepare the student to meet health professional school admission requirements. (See also [Medical Career Advisory Committee](#)).

### **Chemistry Minor**

A minor in chemistry is comprised of five full courses in CHE courses including CHE 202 (or Honors CHE 202) and four other CHE courses numbered 300 or higher, but not including CHE 316, 317, 318, 399, 490 or 493. The minimum grades in CHE 201, CHE 202, and CHE 331 and the minimum GPA for retention and completion of the minor are the same as for the major.

### **Study Abroad**

Students pursuing a degree in chemistry may study abroad for a semester. Any student interested in studying abroad should meet with his/her faculty advisor before the sophomore year in order to plan a curriculum so that the student may complete his/her studies in four years. An appointment with the college's Center for Global Engagement is also required. The student must receive approval from the chair of chemistry in order for options courses taken abroad to count toward requirements for the major.

**Appendix– Program Planners**

Chemistry department planners for each degree option may accessed by clicking of the following links:

	Chemistry Liberal Arts Degree Programs	Secondary Education Degree Programs
ACS certified BS Chemistry degree	<a href="#">CHEM_BS_03</a>	<a href="#">CHEM_BS_04</a>
ACS certified BS Chemistry degree, with research	<a href="#">CHEM_BS_01</a>	<a href="#">CHEM_BS_02</a>
BS Chemistry Degree	<a href="#">CHEM_BS_05</a>	<a href="#">CHEM_BS_06</a>