

Chemistry

Faculty: Chan, *Chair*; Abourahma, Baker, Bradley, Bunagan, Ekanger, Guarracino, Hirsh, Hunt, Hunter, O'Connor, Sen

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 and across disciplines via the Biochemistry and Materials Science specializations.

The Chemistry Department has a strong sense of community with a Student Chemists Association (part of the American Chemical Society (ACS) Student Affiliates), a student chapter of the American Society for Biochemistry and Molecular Biology (ASBMB), 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 the ACS certification.

TCNJ chemistry graduates can pursue advanced degrees in analytical, forensics, organic, inorganic, materials science, physical chemistry, biochemistry, and computational chemistry at leading Masters and Ph.D.-level programs throughout the country. TCNJ chemistry 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.

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

high school preparation for an entering chemistry major at TCNJ includes a year each of college preparatory chemistry, physics, and biology. The quantitative nature of chemistry requires a solid mathematics background encompassing as much mathematics as possible, including algebra, geometry, trigonometry, and calculus, if available. Enrollment in Advanced Placement (AP) Chemistry is useful, but not required. Experience with word processing, spreadsheets, and presentation software is helpful, as is coursework or outside experience in computer programming. Four years of English encompassing solid writing skills are also important to success in the study of chemistry.

General Department Policies for All Students

A. Advanced Placement (AP) Scores

The Chemistry Department policy is for all student course selections to be made by the student in consultation with their academic advisor and/or the Department Chair. An AP score of 4 can provide credit for CHE 201/General Chemistry I. An AP score of 5 can provide credit for both CHE 201 and 202/General Chemistry I and II. While students with a chemistry AP score of 5 may receive credit for CHE 201 and CHE 202, the Department usually recommends that they take CHE 202 or HON 202 before enrolling in higher-level Chemistry courses. We make this recommendation for the following reasons: 1) The TCNJ General Chemistry curriculum provides an important foundation for higher-level chemistry courses; 2) Many students take AP Chemistry their junior year in high school and find that they have forgotten much of the material by their first year in college; 3) A high level of laboratory competency will be gained in CHE 201 and 202 (most high school chemistry courses do not provide the laboratory experience needed for students to operate comfortably in higher-level laboratories); 4) First year is a period of adjustment and in addition to technical and critical thinking skills, the CHE 201 and 202 curricula emphasize time management and study skills required for upper-level chemistry courses; and 5) Students who take Organic or Analytical Chemistry in their first semester at TCNJ generally struggle in these courses.

Students with a strong high school laboratory background, a Chemistry AP score of 5, AP credit in Physics or Mathematics, and a high level of personal maturity are encouraged to enroll directly in courses such as CHE 310/Analytical Chemistry or CHE 331/Organic Chemistry I. Many students choose to fulfill liberal learning or language course requirements during their first year, in lieu of taking upper-level chemistry courses. All decisions about course enrollment should be made in consultation with the student's academic advisor and/or the Department Chair.

B. Repeating a Course

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 a family life event while taking the chemistry course. Students wishing to take a course more than two times must complete a [Repeat of Course Authorization Form](#).

C. Progression in the Chemistry Course Sequence

Enrollment in CHE 202, CHE 310, CHE 331, and CHE 332 requires that the student has earned a minimum grade of C- in the pre-requisite courses (see Table). The Chemistry Department has found that students earning grades lower than C- in pre-requisite courses will struggle significantly in the subsequent course. It is recommended that students repeat the course immediately in the next semester. 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 and will do so at the end of each semester for students who do not meet the minimum grade requirement. Please note that any student enrolled in courses with improper grade pre-requisites is in violation of TCNJ's academic integrity policy. Please note that although these grades are required to continue to the next course, the performance standards for chemistry majors for CHE 201/HON 201, CHE 202/HON 202, CHE 331 and CHE 310 are different (as indicated in Section B1 below).

To enroll in	A minimum grade of C- is required in
CHE 202	CHE/HON 201
CHE 310	CHE/HON 202
CHE 331	CHE/HON 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, the student's chemistry courses must be completed at TCNJ unless the courses are part of a TCNJ's study abroad program and have been pre-approved by the Chemistry Department or pre-approval is granted by the Department Chair. See below for more information about study abroad.

Transfer students are required to take a minimum of four course units of chemistry (courses numbered CHE 310 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/HON 201 General Chemistry I (minimum grade of C)
 CHE/ HON 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) Correlate coursework (PHY, MAT) and other non-major courses can be taken at other institutions and transferred to TCNJ, in accordance with TCNJ policy (see Undergraduate Bulletin for full details). Enrollment in 300-level or higher equivalent courses at another institution are generally not approved except under extenuating circumstances (e.g., enrollment in a pre-approved chemistry course during a study abroad semester, enrollment in a course currently not scheduled at TCNJ)
- 3) Graduation requires a GPA of 2.0 in courses required for the major.
- 4) Please refer to *Transferring into the Major* for program entrance requirements.

C. Writing across the Chemistry Curriculum

The intellectual and scholarly growth of all College of New Jersey students is fostered through TCNJ's writing intensive curriculum. "The goal is for students to become ... good writers who can communicate clearly and effectively to an array of audiences for a range of purposes." Students who graduate from TCNJ with a degree in Chemistry are expected to research, conduct, and document chemical experiments and to communicate their findings to both chemists and non-chemists. The chemistry department's mid- and upper level courses provide a variety of writing assignments that in combination fulfill TCNJ's mid-level and capstone writing intensive requirements. Below is a grid listing the writing activities associated with each of the core courses at the 300- and 400-levels.

Writing Level	Writing Activity	Identified Courses
Introductory level	Laboratory notebooks	CHE 331, CHE 332, CHE 310
Mid-level	Layman summary	CHE 371, CHE 430, CHE 451
	Journal style paper	CHE 372, CHE 430, CHE 451, CHE 493 (typically occurs at the completion of 1 course unit)
	Scientific article analysis	CHE 430, CHE 451, CHE 493

	Laboratory Reports	CHE 371, CHE 372, CHE 430, CHE 451
	Scientific abstract	CHE 393 and CHE 493
	Poster presentation	CHE 451, CHE 493 (typically occurs at the completion of 1 course unit)
	Oral presentation	CHE 316, CHE 430, CHE 451, or select advanced options courses
Advanced level	Original research proposal	CHE 451, select advanced options courses
	Literature review	Select advanced options courses, including CHE 493
	Research report	CHE 493 (typically occurs at the completion of 2 or more course units)
	Research poster or oral presentation	CHE 493 (typically occurs at the completion of 2 or more course units)
	Lesson Plans	CHE 490

Transferring Into the Major

Students may transfer majors as either internal or external transfers. Whatever the circumstances, students who transfer into the TCNJ Chemistry major must take a minimum of four course units of chemistry (courses numbered CHE 310 or above), in addition to satisfying all remaining requirements for the major, to graduate with a chemistry degree from The College of New Jersey.

Any currently enrolled student has the right to apply and be considered for entrance into an academic major in accordance with program entrance standards (see section on Departmental/Program Entrance, Retention, and Exit Standards). Students should understand, however, that certain majors may not be able to accept them because of high student demand. Students seeking to change a major should begin the process as early as possible in the semester in which they wish to change their major. This will help to ensure that students will meet any departmental deadlines and/or the campus wide deadline dates as established by the Office of Records and Registration and posted annually on the [academic and registration calendar](#). It also will provide time for the new program/plan (if approved) to be effective for the next registration period. Students may download the [Undergraduate Change of Major Form](#). Students should also print a copy of their TCNJ unofficial transcript from the PAWS Student Services Center and submit it with the form. Successful applications for internal transfer to the chemistry major must have earned a grade of C+ or higher in CHE 201, General Chemistry I, and PHY 201, General Physics I. However, admission to the Chemistry major is competitive. Internal transfer candidates may also be evaluated using the following criteria.

1. GPA in Chemistry courses and correlate courses for the major (Physics and Mathematics)
2. Number of Chemistry courses or correlate courses completed
3. Overall GPA

Programs Within Chemistry

Students can obtain one of three possible BS degrees in chemistry, two of which are American Chemical Society (ACS) certified 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. This degree is well-suited 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. This degree is well-suited for students interested in working in industry or obtaining a graduate degree in chemistry or related fields.

BS Chemistry Degree. This degree is well suited for students pursuing careers in secondary education, health related fields or interested in obtaining a double-major.

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

- 1) Biochemistry Specialization.** This specialization is meant for students who are interested in molecular biology, biochemistry, biophysics, bioanalytical, bioorganic, and/or bioinorganic chemistry. Students pursuing this specialization gain insight into the interdisciplinary nature of chemistry, biology and physics and wish to pursue interdisciplinary post-graduate goals (i.e. in industry, medical, or graduate programs).
- 2) Materials Science Specialization.** This specialization is appropriate for students interested in materials science, biophysical chemistry, nanotechnology, crystal engineering, magnetism, and related fields that bridge the fields of Chemistry and Physics.
- 3) 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 should be completed no later than the second semester of the first year in order to complete the degree in four years.
- 4) Seven-year BS Chemistry/MD Program.** This program applies only to students who entered TCNJ as part of the TCNJ/NJMS Seven-Year BS Chemistry/MD program. (See the [Seven-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*).

Students entering TCNJ as chemistry majors are initially enrolled in the ACS-certified B.S. program (non-research track) but may transfer to other degree tracks using the Change of Major form. 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:

Chemistry Core Courses (9.5 Course Units)	
CHE/HON 201/General Chemistry I	1 course unit
CHE/HON 202/General Chemistry II	1 course unit
CHE 310/Analytical Chemistry	1 course unit
CHE 331/Organic Chemistry I	1 course unit
CHE 332/Organic Chemistry II	1 course unit
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 course unit total
Correlate Courses (4 Course Units)	
MAT 127, 128/Calculus A, B	2 course units
PHY 201, 202/Physics I, II	2 course units
Options Courses^a (5 or 3 Course Units, see Chemistry Degree Programs Table below)	
<i>See course descriptions for prerequisites</i>	
CHE 370/Special Topics in Chemistry	
CHE 410/Advanced Analytical Chemistry– Instrumental Analysis	
CHE 451/Inorganic Chemistry– Structure and Bonding	
CHE 470/Advanced Topics in Chemistry	
CHE 474/Special Topics in Biochemistry	
CHE 476/Special Topics in Organic Chemistry	
CHE 478/Special Topics in Materials Science	
CHE 493/Independent Research	

^a 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 Degree Programs	Additional requirements beyond the core course requirements	Materials Science Specialization	Biochemistry Specialization
ACS certified BS Chemistry degree	One Chemistry Option 300- or 400- level course with laboratory ^a	Available option	Available option

	Two Chemistry Options 400 level with laboratory (CHE 410 is strongly recommended) ^a		
ACS certified BS Chemistry degree, with research	One 300- or 400-level Chemistry Option course, with <i>or without</i> laboratory Two 400-level Chemistry Options courses, with <i>or without</i> a laboratory ^b Two units of CHE 493 Independent Research	Available option	Available option
BS Chemistry Degree	One Chemistry Option 400-level course, with <i>or without</i> laboratory Two Chemistry Options 300- or 400-level course, with <i>or without</i> laboratory ^c		Available option

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

^b A third semester of CHE 493/Independent Research may substitute for the 300 level option. Note that students taking a third semester of CHE 493 must still take two 400 level options to complete their degree requirement.

^c Enrollment in CHE 493 will be accepted for up to 1 unit and will only count as fulfilling the 300-level course requirement.

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 <i>or</i> BS Chemistry Degree] ^a	See full description of program, below
Seven-year BS Chemistry/MD Program	BS Chemistry Degree	See description of program, below

^a Student Teaching may be used to satisfy a 300 level Chemistry Options course.

1. Materials Science Specialization

The Materials Science 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 B.S. in Chemistry and a Materials Science Specialization. Students will be prepared to pursue a wide variety of careers or graduate study in chemistry, biophysics, or materials science.

To complete the Materials Science Specialization, students must complete the following coursework in addition to all requirements for the B.S. 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 Structure and Bonding, CHE 478/Special Topics in Material Science (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 PHY course greater than 200-level and at least one 300/400-level CHE options course.

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 formally apply for Materials Science as their specialization using the [Undergraduate Change of Major Form](#).

2. Biochemistry Specialization

The Biochemistry specialization brings together the fields of molecular biology, genetics, general, organic and physical chemistry, and meets the interests and needs of a growing population of TCNJ chemistry students with interdisciplinary interests. Students pursuing the specialization see the interconnectedness of these disciplines and wish to pursue post graduate goals that tie together biological aspects of chemistry through medical, graduate or industrial positions. Students will graduate with a B.S. in Chemistry with a specialization in Biochemistry. The B.S. may be American Chemical Society (ACS) approved or non-ACS approved and can be with or without a research-intensive focus.

To complete the Biochemistry Specialization, students must take the standard chemistry core courses, with the option to take *either* CHE 371 (Quantum Chemistry) *or* CHE 372 (Chemical Thermodynamics). In addition, required Correlate Courses include the standard Math and Physics courses for a B.S. in Chemistry, as well as BIO 201 (Foundations in Biological Inquiry) and BIO 211 (Eukaryotic Cell). Students are also required to take either two CHE 474 Advanced Topics in Biochemistry courses (including those that may be cross-listed from other CHE 47X) or CHE 474 (or cross-listed CHE 47X) with BIO 471 (Genomics and Bioinformatics) or BIO 470 Special Topics class from an approved list.

Depending on their degree track, Chemistry majors pursuing the Biochemistry Specialization would have the following options course requirements:

ACS w/Research: One options course at the 300 or 400 level and two units of CHE 493 Independent Research *or* three full units of CHE 493 Independent Research.

ACS: One options course with lab at the 300 or 400 level.

Non-ACS: No options courses are required.

Students may apply for the specialization at any time but are encouraged to do so earlier, such as in their sophomore year, to aid in planning for timely completion. To enroll in the program, students should formally apply for Biochemistry as their specialization using the [Undergraduate Change of Major form](#).

3. Chemistry Secondary Education Program

The Chemistry Secondary Education program provides TCNJ students with a B.S. degree in Chemistry and Secondary Education certification. Students must complete the requirements for one of the Chemistry Degree Programs, 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. In order to advance to candidacy in the program and participate in Clinical Practice I (SED 399/Pedagogy in Secondary Schools, PHY 390/ Pedagogy in Secondary Schools, and RAL 328/Reading in Secondary Education), students must fulfill one of the following: 1) passed the Praxis Core Academic Skills of Educators test with scores of 156 in reading,

150 in math, and 162 in writing (<https://www.ets.org/praxis/about/core/content/>); 2) achieved SAT scores of 610 (Reading) and 570 (Math) or higher ; or 3) achieved ACT scores of 23 or higher in both Reading and Math. In addition, students must achieve a grade of B- or better in EFN 299, SED 224, and SPE 103. Prior to Clinical Practice II (CHE 490/Student Teaching and SED 498/Collaborative Capstone for Professional Inquiry), students must achieve a minimum of B- in all Clinical I courses, have a 3.0 GPA (overall), and take the Praxis II in the content area. To earn certification, students must earn a B- in all Clinical II courses, pass the Praxis II, earn a 3.0 GPA (overall), and pass edTPA, the student teaching portfolio assessment. These requirements should be discussed with the student's academic advisor(s).

Professional Education Sequence (9 Course Units)	
SED 099/ Education Seminar	0 course units
SED 224/Adolescent Learning and Development	1 course unit
EFN 299/School and Communities	1 course unit
SPE 103/Social and Legal Foundations of Special Ed.	1 course unit
SED 399/Pedagogy in Secondary Schools	1.5 course units
PHY 390/Methods of Teaching Science	1 course unit
RAL 328/Reading in Secondary Education	0.5 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) Fall Semester	Spring Semester
FSP/First Seminar CHE 099/Orientation to Chemistry XXX/Liberal Learning/Language ^a CHE 201/General Chemistry I MAT 127/Calculus A PHY 201/General Physics I	SED 099/ Education Seminar CHE 202/General Chemistry II MAT 128/Calculus B PHY 202/General Physics II WRI 102/Academic Writing ^b

^a It is recommended that students exempted from the language requirement take another liberal learning course. ^b It is recommended that students exempted from this course take another liberal learning or language course.

4. Seven-year BS Chemistry/MD Program degree

Admission to this program is dependent on dual acceptance into TCNJ and Rutgers NJMS programs. Applicants are reviewed and evaluated prior to matriculation at TCNJ. 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 Molecules, Cells, and Systems at NJMS as a substitute for CHE 430/ Biochemistry; and 3) enrollment in CHE 493 at TCNJ as substitute for NJMS research requirement. Students in the Seven-year B.S. Chemistry/M.D. Program should take BIO 201/ Foundations of Biological Inquiry their first year at TCNJ.

Relevant Changes to the Core Curriculum for the B.S. Chemistry/M.D. Program

- BIO 231/Genetics (counts as one Chemistry 300 level options course)
- Phase I: Core Biomedical Curriculum/Molecules Cells, and Systems at NJMS (counts as CHE 430)

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 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 CHE courses including CHE 202 (or HON 202) and four other CHE courses numbered 310 or higher, but not including CHE 316, 317, 399, or 490. The minimum grades in CHE/HON 201, CHE/HON 202, CHE 331 and CHE 310 and the minimum GPA for retention and completion of the minor are the same as for the major. Applicants interested in obtaining a Chemistry Minor must complete the TCNJ [Application for Minor form](#) and provide a copy of their unofficial transcript, which should include at least three completed TCNJ Chemistry courses. The Application for Minor form should be submitted to the Chemistry main office, C-108.

Study Abroad

Students pursuing a degree in chemistry may study abroad for a semester. Any student interested in studying abroad should meet with their faculty advisor before the sophomore year in order to plan a curriculum so that the student may complete their studies in four years. An appointment with the College's [Center for Global Engagement](#) is also required.

Students are free to choose the overseas institution where they wish to study under the guidance of the Center for Global Engagement. However, the University of Newcastle (UON) in Australia has a large number of equivalent courses in Chemistry that fulfill core and advanced options requirements. For other universities abroad, student must receive pre-approval from the Chair of Chemistry in order for the courses to count toward requirements for the major.